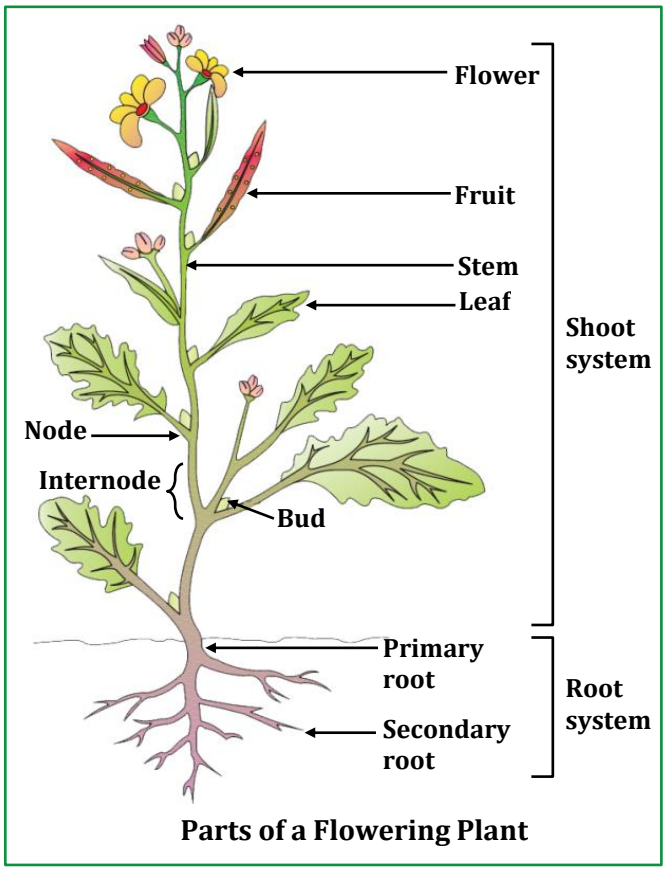
01 Morphology of Flowering Plants

1. Introduction :

- The angiosperms show large diversity in external structure or morphology
- The angiosperms are characterized by presence of roots, stems, leaves, flowers and fruits
- The underground part of flowering plant is the root system while the portion above the ground forms shoot system



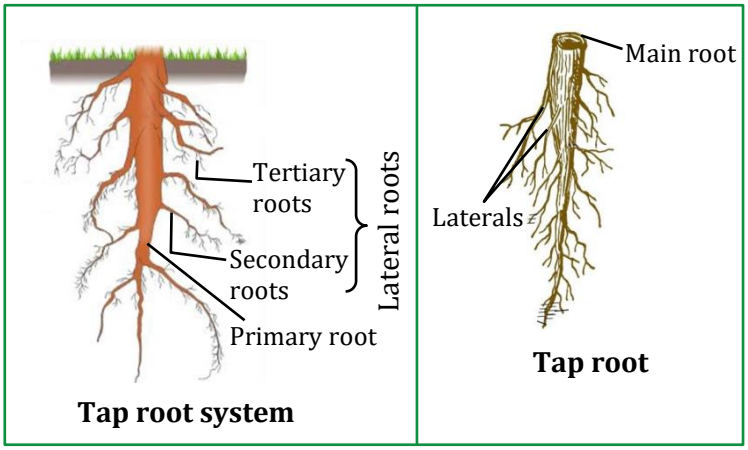
Parts of a Flowering Plant

2. The Root :

Roots are (+) vely geotropic, (+) vely hydrotropic, (–) vely phototropic.

(1) Types of Roots :

(A) Tap Roots : In most of the dicot plants, the direct elongation of the radicle leads to the formation of primary root. It bears lateral roots of several orders that are referred to as secondary, tertiary roots, etc. The primary roots and its branches constitute the tap root system. ***e.g.*** : Mustard plant



(B) Adventitious Roots : In some plants, like grass, Monstera and the banyan tree, roots develop from parts of the plant other than the radicle and are known as adventitious roots.

(C) Fibrous Roots : In **monocot plants**, the primary root is short lived and is replaced by a large number of roots. These roots originate from the base of the stem and constitute the **fibrous root system.** ***e.g.*** **:- Wheat plant.**

Adventitious roots

Fibrous roots

Functions of the root system :

- Absorption of water and minerals. provide a proper anchorage to the plant parts,
- storage of reserve food material (Carrot, radish, turnip, sweet potato and Asparagus) and
- synthesis of PGR (plant growth regulators).

(2) Modification of Root :

- Roots in some plants change their shape and structure and become modified to perform functions other than absorption and conduction of water and minerals.

(A) Modification of Tap Root :

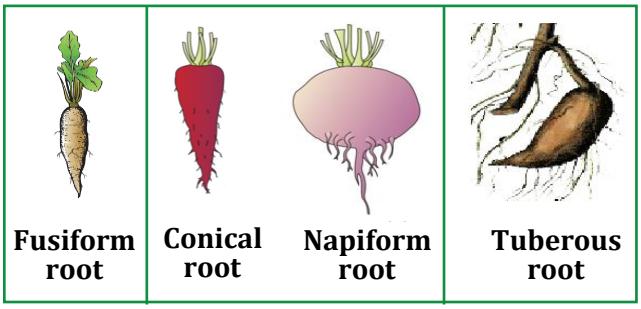
(i) For Food Storage :

(a) Fusiform roots/Spindle shaped roots - These roots are thicker in the middle and tapering on both ends. ***e.g.*** **Radish**

(b) Conical roots - These roots are broader at base and gradually tapper towards apex ***e.g.*** **Carrot**

(c) Napiform roots - These roots become swollen and spherical at upper end and tapering (like a thread) at their lower end. ***e.g.*** **Turnip**, **sugarbeet** = beet root (*Beta vulgaris*)

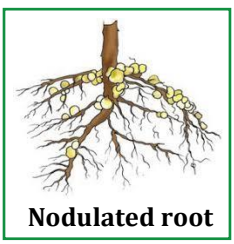
(d) Tuberous roots - These roots do not have regular shape and any portion of roots become swollen & fleshy. e.g. ***Mirabilis***.



Fusiform root | **Conical root** | **Napiform root** | **Tuberous root**

(ii) For N_2-Fixation :

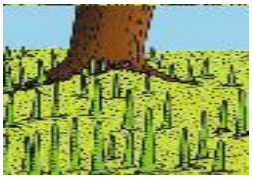
- **Nodulated roots -** Nodules are formed on branches of roots by nitrogen fixing bacteria (*Rhizobium*). ***e.g.*** **Pea, gram, bean**



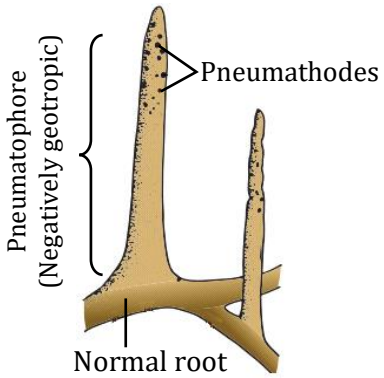
Nodulated root

(iii) For Respiration (Pneumatophores) :

- In **marshy/swampy areas,** scarcity of oxygen is found. Some branches of tap root of the plants which grow in this region, grow vertically upward and comes on the surface. These roots are called **pneumatophores** which have minute pores called **pneumathodes** or lenticels by which air enters in the plant and plant gets oxygen for respiration



Pneumatophores in *Rhizophora*



- Pneumatophores are negatively geotropic. ***e.g.*** ***Rhizophora***, (Mangrove plants).

(B) Modification of Adventitious Roots :

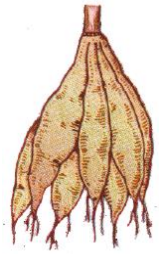
Modification of Adventitious roots

For Storage | **For Support** | **For special function**

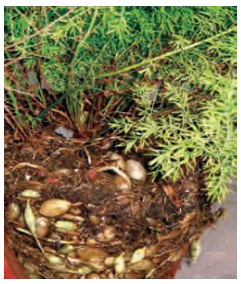
(i) For storage :-

(a) Fasciculated roots : These are adventitious roots occurring in clusters and all of them are swollen. ***e.g.*** ***Asparagus*****, dahlia**

(b) Tuberous adventitious roots : The food is stored in these roots, therefore they become swollen and irregular. These roots have no definite shape ***e.g.*** **Sweet potato** (*Ipomoea batatas*)



Fasciculated roots



Asparagus

Sweet potato

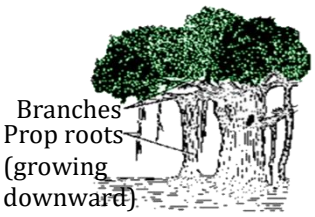
(ii) For support :

(a) Stilt roots or brace roots :- These roots arise from lower node and enter in the soil. These roots are **supporting roots**. ***e.g.*** **Maize, sugarcane**.

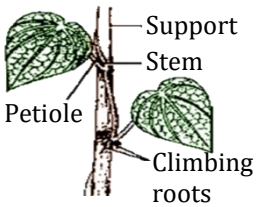
(b) Prop roots or pillar roots :- These hanging roots arise from branches of plant and grow downward towards the soil. These roots **support the tree**. ***e.g.*** **Banyan** (*Ficus benghalensis*)

(c) Climbing roots :- These roots arise from nodes and help in climbing. ***e.g.*** **Money plant** (*Pothos*), ***Monstera*****, betel** (*Piper betel*), **black pepper**.

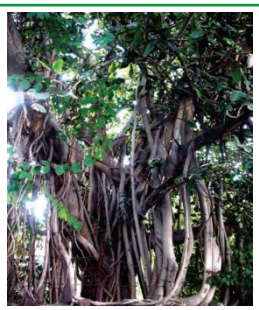
Stilt roots



Prop roots



Climbing roots

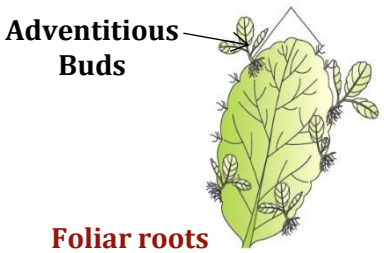


Modification of root for support : Banyan tree

(iii) For Special Function :-

(a) Foliar roots or Epiphyllous roots :– When roots arise from leaf then they are called foliar roots. Help in vegetative propagation ***e.g.*** ***Bryophyllum***.

(b) Sucking roots or Haustorial roots or Parasitic roots : In parasitic plants, roots enter the host plant to absorb nutrition from the host. ***e.g.*** ***Cuscuta***.

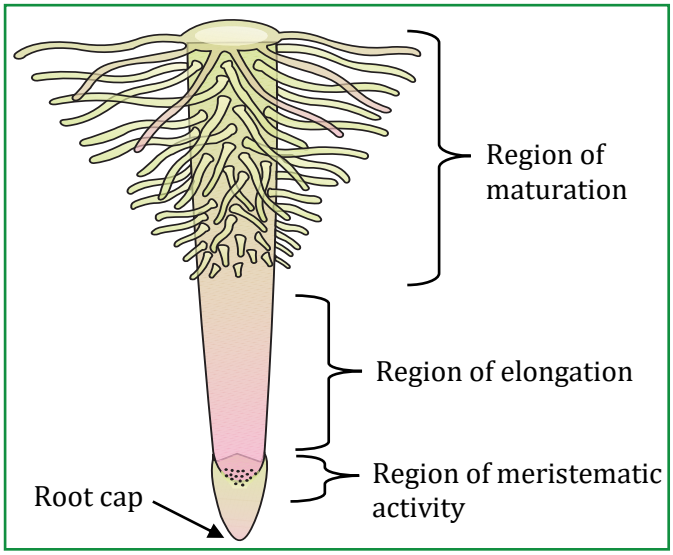


Foliar roots

Parasitic roots

Regions of the Root :

- From this region some of the epidermal cells form very fine and delicate, thread-like structures called root hairs.
- The cells of the elongation zone gradually differentiate and mature.
- The cells of this region are very small, thin-walled and with dense protoplasm. They divide repeatedly.
- It protects the tender apex of the root as it makes its way through the soil.



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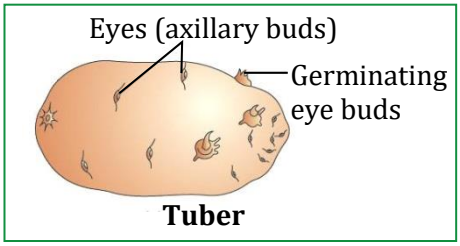
3. The Stem :

- Stem is ascending part of the plant, develops from the plumule of the embryo of a germinating seed.
- The stem bears **nodes** and **internodes**. The region of the stem where leaves are borne are called nodes while the portions between two nodes are called internodes. Stem shows negatively geotropic growth.
- **The main function of the stem** is spreading out branches bearing leaves, flowers and fruits. It conducts water, minerals and photosynthates (food). Some stems perform the function of storage of food (potato, ginger, turmeric, zaminkand and *Colocasia*), support, protection and of vegetative propagation.

(1) Modification of Stems :

- **(A) Underground** Completely below the Soil surface
  - **Rhizome**
  - **Tuber**
  - **Corm**
  - **Bulb**
- **(B) Sub-aerial** Partly aerial and partly underground
  - **Runner**
  - **Stolon**
  - **Sucker**
  - **Offset**
- **(C) Aerial** completely in air or above the soil surface
  - **Stem thorn**
  - **Stem tendrils**
  - **Phylloclade**
  - **Cladode**

(A) Underground modification of stem : This type of modification occurs generally for food storage and vegetative propagation.

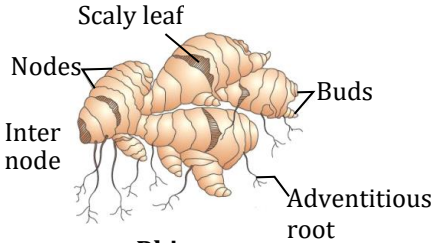


(i) Tuber - The tips of branches become swollen in the soil. **Eyes are found on tuber which are axillary buds** and axillary buds are covered with scaly leaves. ***e.g.*** **Potato**. Peel of potato is periderm.

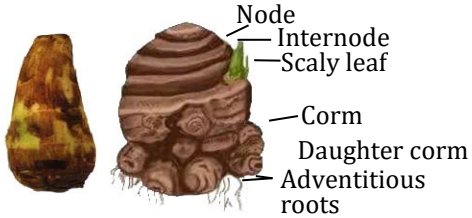
(ii) Rhizome - It is fleshy stem which grows horizontally in the soil. Nodes and small internodes are found which are covered by scaly leaves. ***e.g.*** **Ginger, turmeric, canna, water lily, banana**.

(iii) Corm - It is condensed structure which grows vertically under the soil surface. ***e.g.*** ***Colocasia***, ***Alocasia***, **zaminkand** (*Amorphophallus*), **saffron**, ***Colchicum***, ***Gladiolus.***

Ginger



Rhizome



Zaminkand **Corm**

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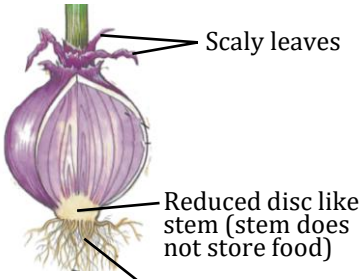
Note : **Organ of perennation -** Underground stems of **potato, ginger, turmeric, *Colocasia*, zaminkand** are modified to store food in them. They also act as organ of perennation to tide over conditions unfavourable for growth.

(iv) Bulb - Stem is highly reduced and disc like and surrounded by numerous fleshy leaves. Many roots arise from its base. ***e.g.*** **Onion, garlic**. The fleshy leaves of onion and garlic store food.



Bulb

Banana is example of both rhizome and sucker stems. Banana propagates through rhizome. Aerial part of banana plant which looks like stem is called pseudo-stem (leaf bases).

(B) Sub-aerial modification of stem : These are **creeping stems**.

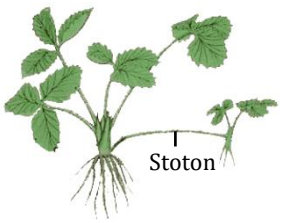
(i) Runner - In these stems roots develop at lower side and leaves at upper side from the nodes. ***e.g.*** ***Cynodon dactylon*** (doob grass), ***Oxalis*****, Strawberry** (*Fragaria ananassa*).

(ii) Stolon - In it branches develop from the lower part of the main stem and grow for some distance like arch and finally touch the ground to give rise to new shoot. ***e.g.*** **Jasmine, peppermint**.

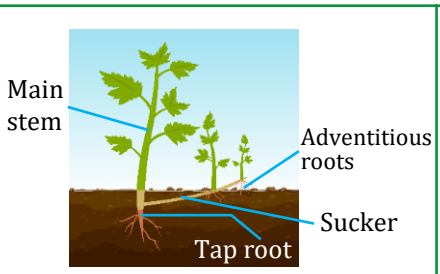
(iii) Sucker - In it the main stem grows in the soil but branches develop from basal and underground nodes and comes out from the soil, obliquely upward giving rise to leafy shoots. ***e.g.*** **Mint, pineapple, *Chrysanthemum*, banana**.

(iv) Offset - Generally these occur in aquatic plants which have fragile stem. Internodes of offset are small & thicker and each node bears a **rosette of leaves** and a **tuft of roots**. It is also known as **aquatic runner**. ***e.g.*** ***Pistia*****, *Eichhornia***.

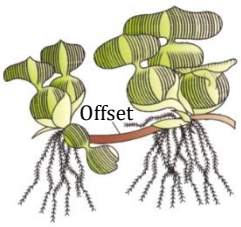
Runner



Stolon



Sucker



Offset

For vegetative propagation

(C) Aerial modification of stem :

(i) Stem tendril - In this type of modification axillary bud forms tendril in place of branches and helps in climbing of those plants which have weak stem. ***e.g.*** **Grapes/Grapevines, *Passiflora*, gourds** (cucumber, pumpkins, watermelon)

(ii) Stem thorn - Thorn develops usually from axillary bud of the stem. It may bear leaves, flowers. ***e.g.*** ***Carissa*** (karonda), ***Bougainvillea*****, pomegranate, *Citrus***

- **Thorn protects plant from browsing animals. It is a woody pointed structure.**

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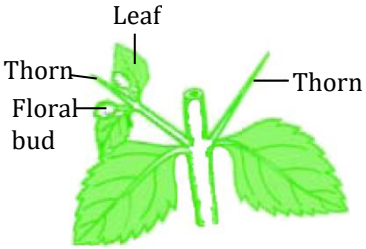
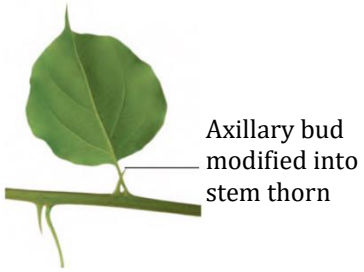
Stem Tendril

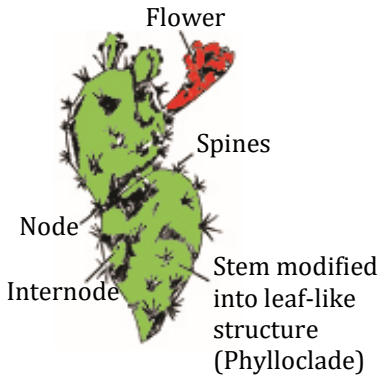




Stem Thorn

(iii) Phylloclade - Stem is modified into a fleshy flat (***Opuntia***) or fleshy cylindrical (***Euphorbia***) and green leaf like structure and carries out photosynthesis like leaf. The leaves are modified into spines. ***e.g. Opuntia* (cactus), *Euphorbia***.

(iv) Cladode : In this modification branches of limited growth become green and flat like a leaf and perform photosynthesis. e.g. ***Asparagus*** (one internode long), ***Ruscus*** (2 internode long).

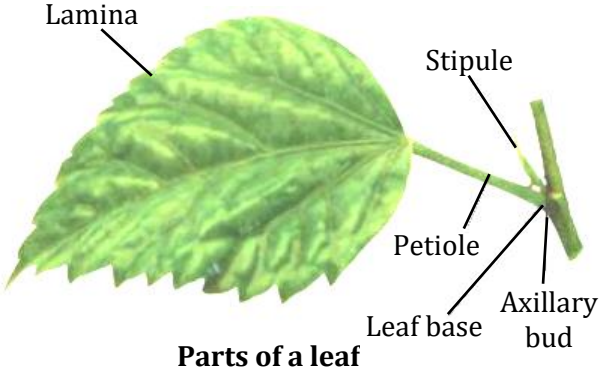


Phylloclade

Cladode

4. The Leaf :

- The leaves develop from the nodes. Their main function is to carry out photosynthesis or food formation.
- Axillary buds are found in the axil of leaves. The axillary bud may develop into a branch.
- Leaves originate from shoot apical meristems and are **arranged in an acropetal order**.
- Leaf is a lateral outgrowth of stem developed exogenously at the node.



Parts of a leaf

(1) Parts of a Leaf :

A typical leaf **(Phyllopodium)** consist of three main parts :-

(A) Leaf Base : The part of leaf which is attached to stem is known as leaf base. Sheathing leaf base is found in monocots. In monocots, the leaf base expands into a sheath covering the stem partially or wholly. Pulvinus leaf bases are found in some legume plants. Swollen leaf base is known as pulvinus leaf base.

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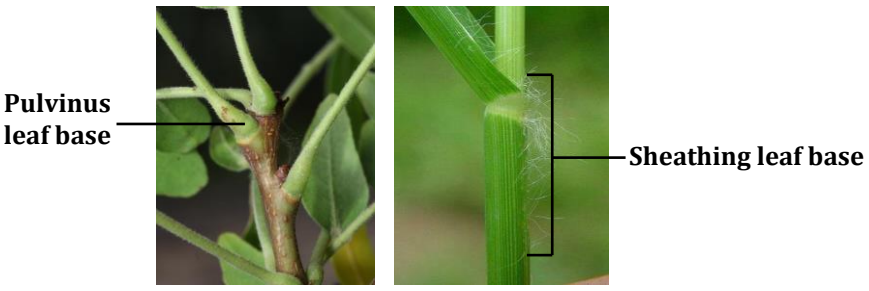
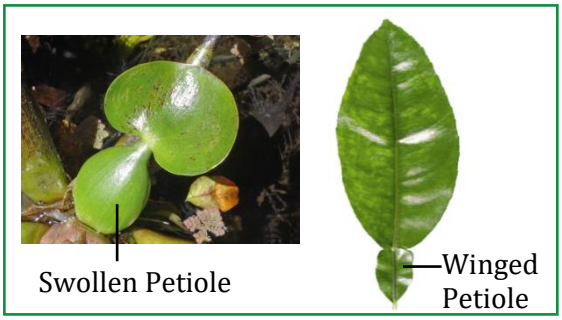


(B) **Petiole :** The part of leaf connecting the lamina with the branch or stem is known as petiole. Petiole or stalk containing leaves are known as **petiolate leaves** and when petiole or stalk is absent then leaves are called **sessile**. The petiole helps hold the blade to light. Long thin flexible petioles allow leaf blades to flutter in wind, thereby cooling the leaf and bringing fresh air to leaf surface. In ***Eichhornia*** petiole swells up and in ***Citrus*** it is winged.



(C) **Lamina (Leaf Blade) :** Leaf blade is the green expanded part of the leaf with veins and veinlets. There is, usually, a middle prominent vein, which is known as the midrib. Veins provide rigidity to the leaf blade and act as channels of transport for water, minerals and food materials. The shape, margin, apex, surface and extent of incision of lamina varies in different leaves.

(2) Venation :

The arrangement of veins and veinlets in leaf lamina is known as venation.

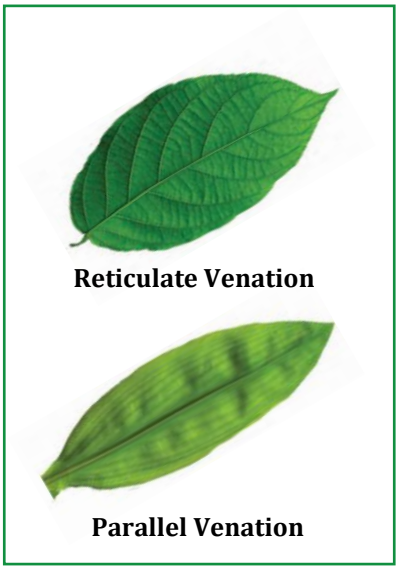
Types of Venation – Venation is of two types –

(A) **Reticulate :** When the veinlets form a network, the venation is termed as reticulate. Leaves of dicotyledonous plants generally possess reticulate venation.

Exception : *Calophyllum* (It has parallel venation)

(B) **Parallel :** When the veins run parallel to each other within a lamina, the venation is termed as parallel. Parallel venation is the characteristic of most monocotyledons.

Exception : *Smilax* (It has reticulated venation)



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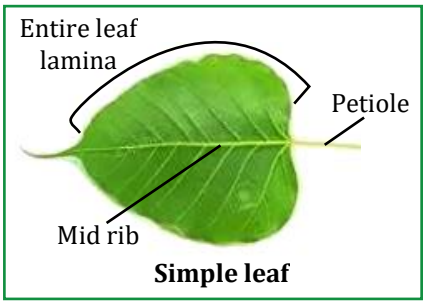
(3) Types of Leaves :

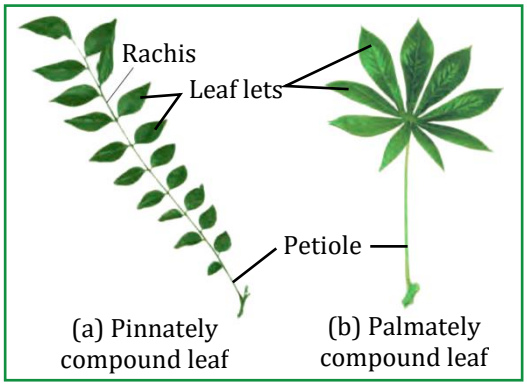


Simple leaf

(A) Simple Leaf : A leaf is said to be simple, when its lamina is entire or may be incised to any depth, but not up to the midrib or petiole. ***e.g.*** **Peepal, Mango, Radish**.

(B) Compound Leaf : A leaf in which the leaf blade (lamina) is incised up to the midrib or petiole, thus dividing it into several small parts, i.e. leaflets.

It has two types :–



(i) Pinnately Compound Leaf :-In this type of leaf, leaf blade (lamina) is incised upto the mid rib and mid rib is known as rachis. A number of leaflets are present on a common axis, the rachis. ***e.g.*** **Neem**

(ii) Palmately Compound Leaf :-In this type incisions of leaf are directed from leaf margins to apex of the petiole and all leaflets are attached at a common point i.e. at the tip of the petiole. Rachis is absent in palmately compound leaf. ***e.g.*** **Silk cotton** (*Bombax*).

- **A bud is present in the axil of petiole in both simple and compound leaves, but not in the axil of leaflets of the compound leaf.**

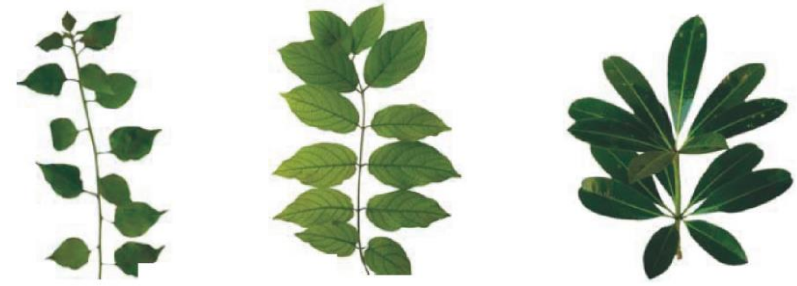
(4) Phyllotaxy :

Phyllotaxy is the pattern of arrangement of leaves on the stem or branch. This is usually of three types.

(A) Alternate : In this type a single leaf arises at each node at alternate manner. ***e.g.*** **Mustard, Chinarose, Sunflower**.

(B) Opposite : In this type of phyllotaxy a pair of leaves arise at each node and lie opposite to each other. ***e.g.*** **Guava, *Calotropis*, *Ocimum***

(C) Whorled : If more than two leaves arise at each node and form a whorl, then it is called whorled phyllotaxy. ***e.g.*** ***Alstonia*** (devil tree), ***Nerium***.


(a) Alternate (b) Opposite (c) Whorled

Different types of phyllotaxy

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(5) Modification of Leaves :

When leaves are modified into different structures then it is called modification of leaves.

(A) Leaf Tendril : In some plants whole leaf is modified into a wire like structure which is called leaf tendril. Tendril helps is climbing. ***e.g.*** **Peas**.

(B) Leaf Spine : Leaves are modified into pointed spines. ***e.g.*** ***Opuntia*****, Cacti,** ***Argemone***.

(C) Leaf Pitcher : Leaves of some plants are modified into pitcher shaped structure. ***e.g.*** ***Nepenthes*** (pitcher plant) (Only lamina is modified into pitcher). Water is stored in the pitcher of *Dischidia* (complete leaf is modified into pitcher). In *Nepenthes* insectivorous pitcher while in *Dischidia* - non insectivorous pitcher is formed.

(D) Leaf Bladder : In *Utricularia* (bladderwort plant) leaves get modified into bladders which act as insectivorous structures.

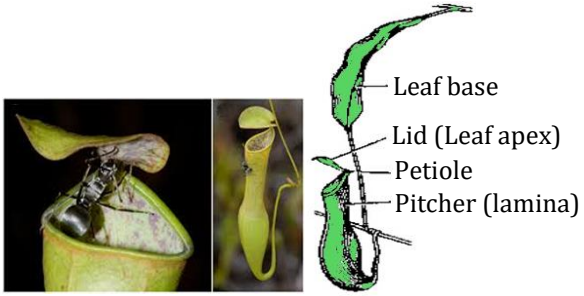
(E) Phyllode : In some plants petiole becomes flat leaf like green, synthesises food and functions as normal leaf. ***e.g.*** : **Australian acacia,** ***Parkinsonia***.

(F) Leaflet Tendril : In ***Pisum sativum*** (garden pea) and ***Lathyrus odoratus*** (sweet pea) leaflets are modified into tendril for climbing.

(G) Fleshy Leaf : In some plants, leaves are become fleshy ***e.g.*** **Onion, Garlic**.

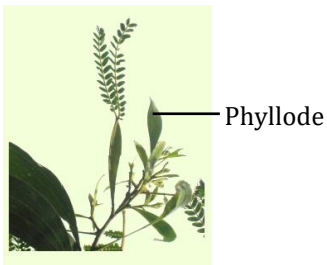
Leaf tendril
(For Climbing)

Leaf spines
(For Protection)

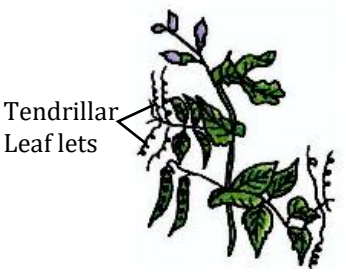


Leaf pitcher

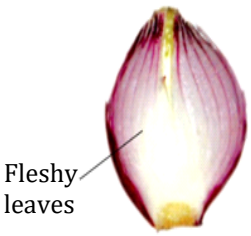
Leaf bladder



Phyllode
(For Photosynthesis)



Leaflet tendril
(For Climbing)



Fleshy leaves
(For Storage)

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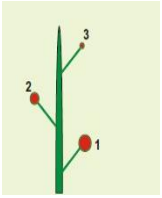
5. The Inflorescence :

- The arrangement of flowers on the floral axis or peduncle is termed as inflorescence.
- Depending on whether the apex gets developed into a flower or continues to grow, two major types of inflorescences are defined – racemose and cymose.

INFLORESCENCE →

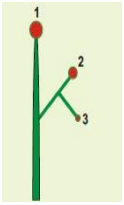
RACEMOSE

Position of flower : **Lateral**
Growth of Peduncle : **Unlimited (Indefinite)**
Floral axis (Peduncle) **doesn't terminate** in a flower
Arrangement of flowers : **Acropetal**
(i.e. younger flower towards apex and older flower towards base of floral axis)



CYMOSE

Position of flower : **Terminal**
Growth of Peduncle : **Limited (definite)**
Floral axis (Peduncle) **terminates** in a flower
Arrangement of flowers : **Basipetal**



(1) Racemose :

- In this type of inflorescence the main axis continues to grow and does not terminate in a flower and flowers are borne laterally in an **acropetal order/acropetal succession**.

Types of racemose inflorescence :

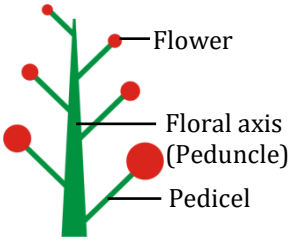
Racemose inflorescence

(A) Raceme : In this type of inflorescence, peduncle (main axis or floral axis) is elongated and **flowers are pedicellate**.

e.g. **Radish, Mustard.**

- When peduncle or floral axis of raceme gets branched and produces pedicellate flowers in acropetal order, it is known as *Panicle* or branched /**compound raceme**.

e.g. ***Cassia, Gulmohar***

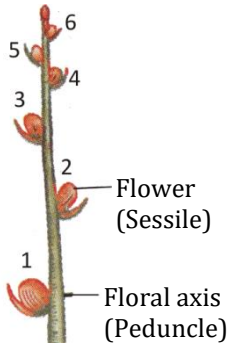


Raceme

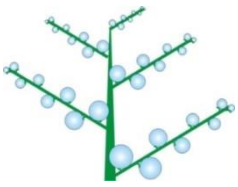
Compound Raceme (Panicle)

(B) Spike : In this type of inflorescence peduncle is elongated but flowers are sessile (without pedicel).
e.g. ***Achyranthes***

- When peduncle is branched and each branch bears spike like inflorescence then the small branch having flowers is called spikelet and this arrangement is called spike of spikelets.
e.g. Wheat (Member of family poaceae).



Spike


Spike of spikelets

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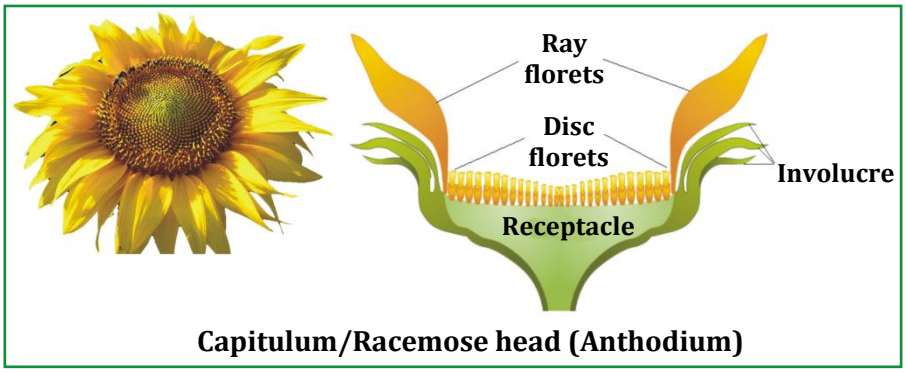
(C) **Spadix :** In this type of inflorescence **peduncle is thick, long and fleshy** and it has small sessile and unisexual flowers covered with one or more **large green or colourful bracts (spathe)**.
e.g. **Maize Colocasia, Maize**.

- Compound spadix e.g. Palms
- **Grain of maize is a fruit** (caryopsis).
- Long filamentous threads (Silky hairs) protruding at the end of a young cob of maize are styles.

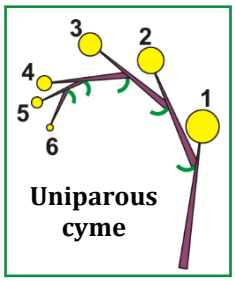
Spadix

(D) **Capitulum/Racemose head (Anthodium) :** In this type of inflorescence tip of peduncle becomes broad, flattened concave or convex **(receptacle)**. On it small sessile flowers are found. These flowers are called **florets**. The florets which are present in centre are small & called **disc florets** and florets which are present at periphery are large & called **ray florets**, florets are arranged in centripetal order.
In this type of inflorescence florets may be unisexual, bisexual and sterile. This inflorescence is surrounded by one or more involucre. It is **most advanced type of inflorescence**, because a single insect can easily pollinate innumerable florets within a very short time without having to fly from one inflorescence to another.
e.g. **Compositae /Asteraceae family [Sunflower, marigold (*Tagetes*)].**



Capitulum/Racemose head (Anthodium)

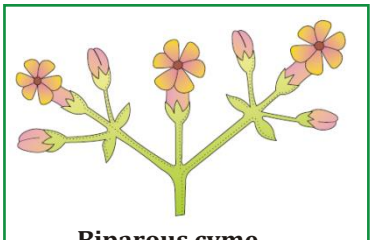
(2) **Cymose :**
In this type of inflorescence, the main axis/peduncle Cymose inflorescence terminates in a flower hence is limited or definite in growth. Flowers are arranged in **basipetal succession/basipetal order**.
Types of cymose inflorescence :



Uniparous cyme

(A) **Uniparous or Monochasial Cyme :** In this type, the peduncle ends in a flower and from lower part of the peduncle each lateral branch forms a single flower in a basipetal order. ***e.g.*** ***Solanum, Atropa.***

(B) **Biparous cyme / Dichasial cyme :** In this type of inflorescence peduncle ends in a flower and from the basal part of peduncle two lateral branches arise which also end in a flower, now this same arrangement occurs on these lateral branches. ***e.g.*** ***Bougainvillea*, jasmine**.


Biparous cyme

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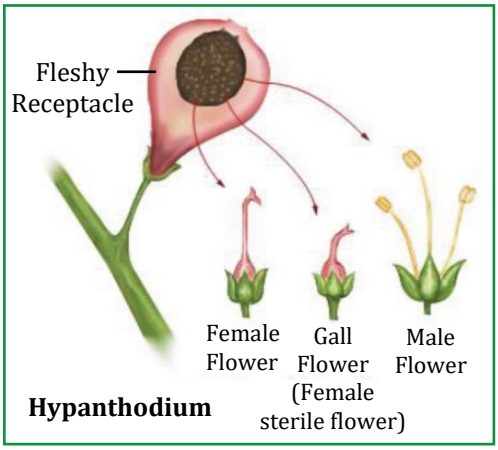
(3) Special Type of Inflorescence :

Hypanthodium :

In this type of inflorescence upper part of peduncle is modified into a pear-shaped structure having cavity with a pore (ostiole). At the base of cavity female flowers develop while towards the pore male flowers develop. All three types of flowers (male, female, sterile female) are present in this inflorescence. ***e.g.*** ***Ficus* species - banyan, fig, peepal.**



Golden Key Points

- Tap roots arise from radicle whereas adventitious roots arise from any other part of plant other than radicle.
- Root cap is thimble like structure.
- *Gladiolus* is an example of corm.
- *Opuntia* and *Euphorbia* are examples of phylloclade.
- In *Nepenthes*, only lamina is modified into pitcher like structure.
- Banana is an example of mixed spadix.
- In *Portulaca* food storing adventitious root is present.

BEGINNER'S BOX-1 THE ROOT TO THE INFLORESCENCE

1. In which of the following type of underground modification of stem, storage of food does not occur in stem?
(1) Bulb (2) Rhizome (3) Corm (4) Tuber

2. Fasciculated roots are found in :-
(1) *Asparagus* (2) *Colocasia* (3) Ginger (4) Turmeric

3. Lamina is also known as :-
(1) Phyllopodium (2) Epipodium (3) Mesopodium (4) Hypopodium

4. Phyllode & cladode are :-
(1) Homologous (2) Analogous (3) Vestigial organs (4) Homoanalogous organs

5. Which of the following region of root is responsible for the growth of the root in length?
(1) Region of meristematic activity (2) Region of elongation
(3) Region of maturation (4) Root cap

6. A few millimetres above the root cap is the region of :-
(1) Elongation (2) Maturation
(3) Meristematic activity (4) Root hairs

7. Which is a modification of root that does not store food?
(1) Napiform root (2) Fusiform root (3) Tuberous root (4) Stilt root

8. Which of the following also act as an organ of perennation to tide over unfavourable conditions for growth :-
(1) Potato, Turnip (2) Onion, Radish (3) Zaminkand, Ginger (4) Ginger, Carrot

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9. Stem tendrils develop from axillary bud. Stem tendrils are present in all of the following, except :-
(1) Cucumber (2) *Citrus*
(3) Pumpkin (4) Watermelon and grapevines

10. Bud is present in axil of petiole in :-
(1) Compound leaf and leaflet (2) Simple and compound leaf
(3) Simple leaf and leaflet (4) Leaflet, simple and compound leaf

11. Thorns and spines are :-
(1) Defensive organs (2) Respiratory organs
(3) Both (1) and (2) (4) Storage organs

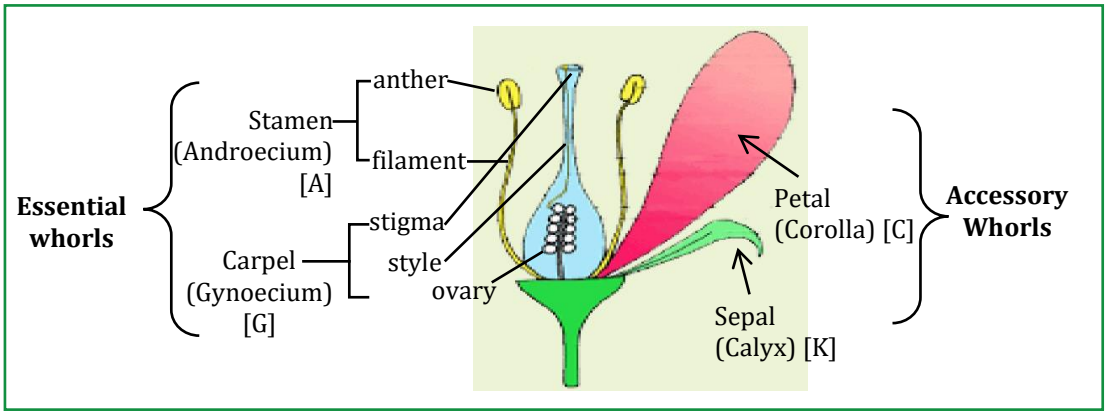
12. Zygomorphic flowers are found in :-
(1) Solanaceae (2) Malvaceae (3) Fabaceae (4) Liliaceae

6. The Flower :

- A flower is a modified shoot where in the shoot apical meristem changes to floral meristem. Internodes do not elongate and the axis gets condensed.
- **When a shoot tip transforms into a flower, it is always solitary.**
- The flower is the reproductive unit in the angiosperms. It is meant for sexual reproduction.
- Generally, flower has a short or long stalk which is called **pedicel**. The upper part of pedicel is swollen, which is called **thalamus**. Floral leaves are present on it.

There are 4 types of floral leaves.
(1) Sepal (2) Petal (3) Stamen (4) Carpel

- A typical flower has four different kinds of whorls arranged successively on thalamus. These are calyx, corolla, androecium and gynoecium.



- Calyx and corolla are accessory organs or accessory whorls while androecium and gynoecium are reproductive organs or reproductive whorls or essential whorls.
- **Complete flower :** All four whorls are present.
- **Incomplete flower :** Any whorl is absent e.g. Unisexual flower.
- **Bisexual flower :** Perfect flower.
- **Unisexual flower :** Imperfect flower.
- A flower may be trimerous, tetramerous or pentamerous when the floral appendages are in multiple of 3,4 or 5, respectively. In dicots flowers are usually pentamerous while in monocots flowers are trimerous.

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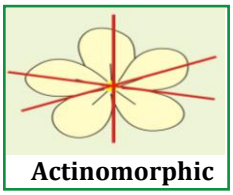
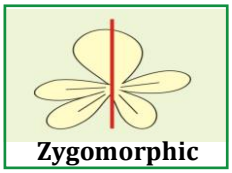
(1) Symmetry of Flower :


Actinomorphic

(A) Actinomorphic/radial/regular : When a flower can be divided into two equal radial halves by any vertical plane or radial plane passing through the centre, then it is said to be actinomorphic flower ***e.g.*** **Mustard, *Datura*, chilli**.


Zygomorphic

(B) Zygomorphic/bilateral : When a flower can be divided into two equal (similar) halves only by one particular vertical plane, then it is said to be zygomorphic flower. ***e.g.*** **Pea, bean, gulmohur, *Cassia*.**

(C) Asymmetrical/irregular : When a flower cannot be divided into two equal (similar) halves from any vertical plane passing through the centre, then it is said to be asymmetrical flower.
e.g. **Canna**.
The part of flower which lies near to the mother axis is posterior part while the part which is far from the mother axis is anterior part of flower.
The position of the mother axis with respect to the flower is represented by a dot on the top of the floral diagram.

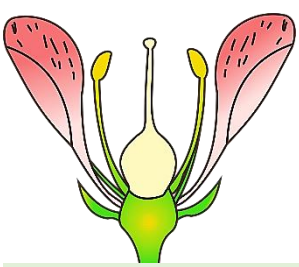
(2) Types of Flowers on the basis of Insertion of Floral Leaves :

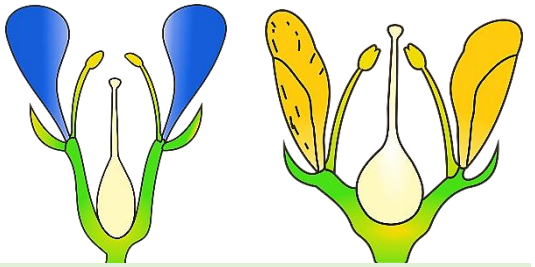
- The relative position of gynoecium changes with respect to floral parts. Based on the position of calyx, corolla and androecium in respect of the ovary on thalamus, the flowers are divided into three types.

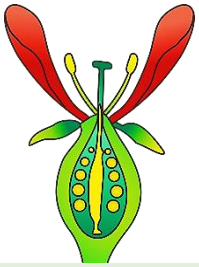
(A) Hypogynous Flower : When gynoecium occupies the highest position while the other parts like petals, sepals and stamens are situated below the ovary, then the flower is called hypogynous and in this condition ovary will be superior. ***e.g.*** **Mustard, China rose, Brinjal, Mango**.

(B) Perigynous Flower : In it thalamus grows upwardly and form a cup shaped structure. On the margin or rim of thalamus floral parts are attached except gynoecium, which lies at the basal part or in the centre. So, in this condition gynoecium is situated below the other floral parts. But ovary in this condition is said to be half inferior. ***e.g.*** **Rose, Plum, Peach**.

(C) Epigynous Flower : When the margin of thalamus grows upward enclosing the ovary completely and getting fused with it and other parts of flower like petals, sepals & stamens are situated above the ovary, then the ovary is said to be inferior and rest of the floral parts superior. ***e.g.*** **Guava, Apple, Cucumber** and the ray florets of sunflower.


Ovary Superior (Hypogynous flower)


Ovary Half inferior (Perigynous flower)


Ovary Inferior (Epigynous flower)

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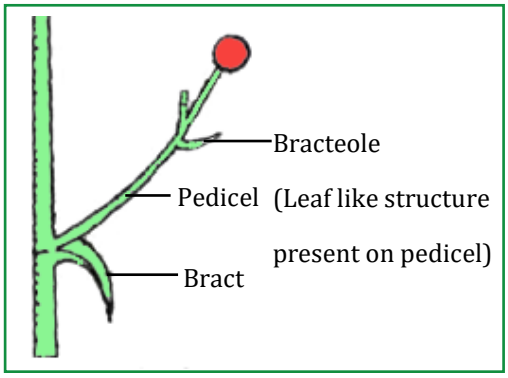
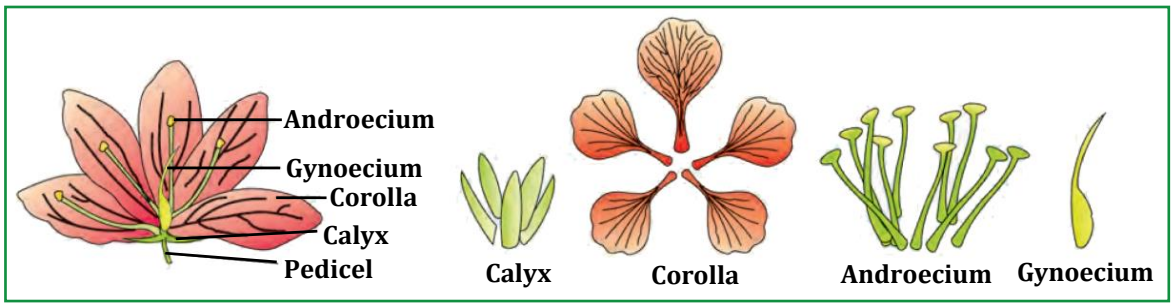
- Bract is a reduced leaf found at the base of the pedicel of flower.
  Bracteate flower - The flower with bract is called bracteate flower.
  Ebracteate flower - Flower without bract is known as ebracteate flower.



- **Involucre** - The whorl of bracts is called involucre.
- **Spathe** - When large bract completely encloses whole inflorescence, then it is called spathe. ***e.g.*** **Banana, maize**
- Petaloid bract - When the size of bract is greater than the size of flower and it is of various coloured like petals, then it is called petaloid bract. ***e.g. Bougainvillea.***
- **Glumes** - Small, dry, scaly bracts are called glumes. ***e.g.*** Wheat (Member of poaceae)

(3) Parts of a Flower :



(A) Calyx :

- The outermost whorl of flower is called calyx. Each member of this whorl is called sepal.
- Sepals are green leaf like and protect the flower in the bud stage.
- In calyx of *Mussaenda*, one of the sepal enlarges and forms a leaf like structure. It may be brightly coloured. It attracts the insects and thus acts as advertising flag/Petaloid sepal.
- In *Trapa*, Calyx is modified into spines and helps in protection of fruits.
- If sepals do not fall and remain attached to fruit, then they are called persistent sepals. ***e.g.*** **Tomato, Chilli, Brinjal, Cotton, Datura**.

(B) Corolla :

- The second whorl of flower is called corolla and each member of corolla is called petal.
- Petals are usually brightly coloured to attract insects for pollination.

(i) Forms of Corolla :

(a) Campanulate/bell shaped : In this type of corolla 5 fused petals are present. It's shape is similar to bell. ***e.g.*** **Tobacco**

(b) Tubular : In this type 5 fused petal form tubular (tube like) or cylindrical structure. ***e.g.*** **Disc florets** of **sunflower**.

(c) Funnel shaped or infundibuliform : In this type 5 fused petal are found. It's shape is similar to funnel. ***e.g.*** ***Datura*****, Petunia**

(d) Wheel shaped/Rotate : In this type 5 gamopetalous petals are found and the fused parts form small tube and the petals are arranged in a whorl above the tube. ***e.g.*** **Brinjal**.

Bell shaped

Tubular

Funnel shaped

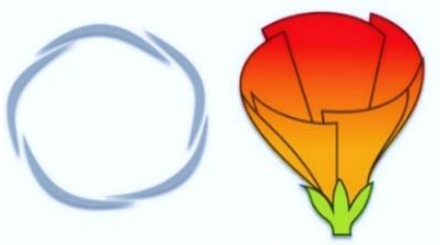
Wheel shaped

(ii) Aestivation :

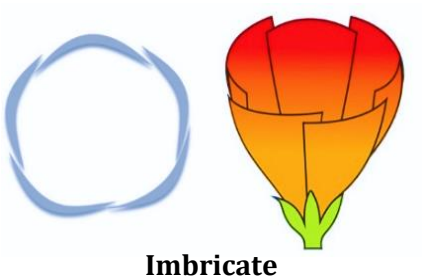
The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as aestivation. It is of following types :-

Valvate

(a) Valvate : When the petal of a whorl lie adjacent to other petal and just touch one another at the margin without overlapping then it is known as valvate aestivation.
e.g. ***Calotropis plant*****, Cruciferae, Solanaceae** & **Liliaceae family**.

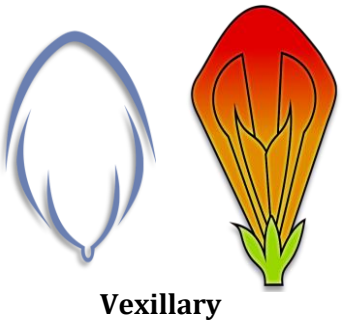

Twisted

(b) Twisted : In this type one margin of a petal covers adjacent petal and the other margin is covered by another petal. One margin of the petal overlaps that of the next one, and the other margin is overlapped by the another one. ***e.g.*** **Cotton, ladyfinger, china rose** (Malvaceae family).


Imbricate

(c) Imbricate : When both margins of the one petal are covered by the other two petals and both margin of another one, covers other. Rest are arranged in twisted manner. OR If the margins of sepals or petals overlap one another but not in any particular direction, then it is known as imbricate aestivation.
e.g. ***Cassia*****, gulmohur (*****Delonix regia*****)**.

- **Ascending imbricate :** The posterior petal is innermost i.e., its both margins are overlapped.
e.g. **Caesalpinoideae** sub-family of **leguminosae**.


Vexillary

(d) Vexillary or Papilionaceous or Descending Imbricate : The posterior petal is outermost and largest and is known as standard or vexillum which overlaps the two lateral petals wings or alae. These two laterals petals overlaps two smallest anterior petals i.e. keel or carina. Vexillary arrangement is found in pea family.
e.g. **Pea, bean** (Fabaceae).

(C) Androecium :

- It is composed of stamens. When the stamens of an androecium are free from one another, then it is called polyandrous condition.
- Sterile stamens are known as **staminodes**.

(i) Attachment of filament to anther lobe :

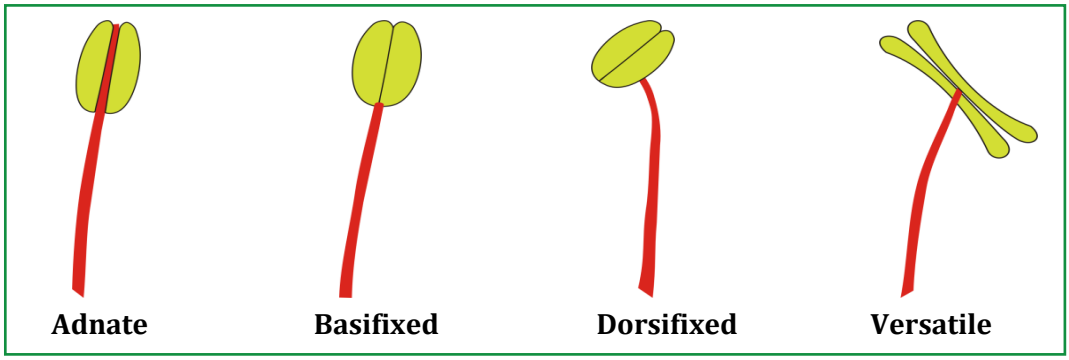
The attachment of filament to another lobe is of four types :

(a) Adnate - Filament runs the whole length of the anther, from the base to the apex. ***e.g.*** ***Michelia* (champa)**

(b) Basifixed - Filament is attached to anther at its base. ***e.g.*** **Datura, radish, mustard**

(c) Dorsifixed - The filament is attached at the centre to the back of the anther. Dorsifixed anther can not swing freely. ***e.g.*** **Members of malvaceae family.**

(d) Versatile - Long filament is attached to the back of the anther at a point only and anther **can swing freely.** ***e.g.*** Wheat, grass, maize (Members of **Poaceae family**).



(ii) Cohesion of stamens :

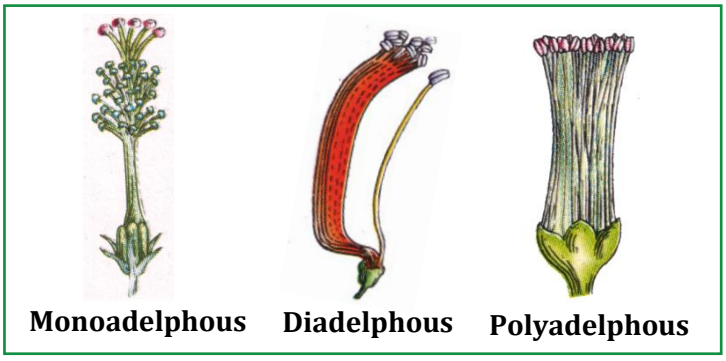
When the floral parts of similar whorl are fused, then it is called cohesion.

When stamens are united by their filaments only, then it is called adelphy. It is of following types–

(a) Monoadelphous - In this type of cohesion all the filaments are united into a single bundle or one bunch but anthers remain free. In this type of cohesion a tube is formed around the gynoecium which is called staminal tube ***e.g.*** **China rose** (Malvaceae family).

(b) Diadelphous - In this type of cohesion filaments are united into two bundles but the anthers remain free. ***e.g.*** **Pea** (Fabaceae). In these plants out of 10 stamens, 9 stamens are united into a bundle while 1 stamen remains free.

(c) Polyadelphous - Filaments are united into more than two bundles. ***e.g.*** ***Citrus***.



(iii) Adhesion of stamens :

When the stamens are attached to other parts of flower, then it is called adhesion of stamens.

(a) Epipetalous - Stamens are attached to the petals. ***e.g.*** **Brinjal** (Solanaceae)

(b) Epiphyllous or Epitepalous - Stamens are attached to the tepals (perianth). ***e.g.*** **Lily** (Liliaceae).

Epipetalous

Epiphyllous

(iv) Length of stamens :

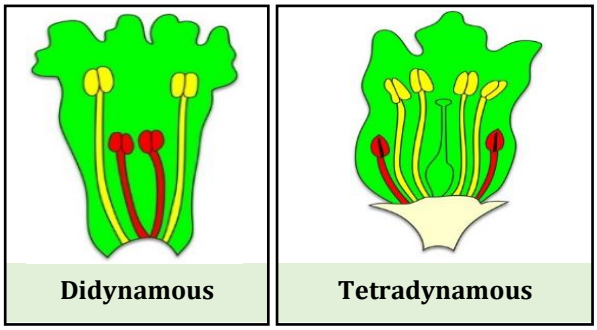
There may be a variation in the length of filaments within a flower, as in Salvia and mustard.

(a) Didynamous - If four stamens are present and out of them two are long and two are short, then it is called didynamous condition.

e.g. **Lamiaceae/Labiatae family** (*Salvia*)

(b) Tetradynamous - When there are six stamens and they are arranged in two whorls. In outer whorl, there are two short stamens while in inner whorl, there are four long stamens, this condition is called tetradynamous.

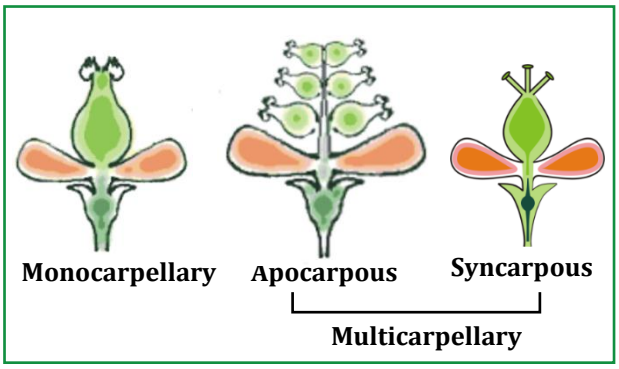
e.g. **Cruciferae family** (Mustard, *radish, turnip*).



Didynamous **Tetradynamous**

(D) Gynoecium :

- Gynoecium is female reproductive organ of the flower and is made up of one or more carpels.
- If only one carpel is present in gynoecium then this condition is called **monocarpellary** condition.
- If more than one carpel is present in gynoecium then this condition is called **polycarpellary** or **multicarpellary**.
- When all the carpels in polycarpellary/ multicarpellary condition are free, then this condition is called **apocarpous**. ***e.g.*** **Lotus, Rose,** ***Michelia***.
- When all the carpels are fused, then this condition is called **syncarpous.** ***e.g.*** ***Papaver,*** ***Hibiscus*****, Mustard, Tomato**.



Placentation :

The ovules are attached on ovary walls on one or more cushion like structure called placenta. The manner in which placenta or ovules are arranged on ovary wall is known as placentation or the arrangement of ovules within the ovary is known as placentation. It is of following types:

(a) Marginal :

This type of placentation is found in monocarpellary gynoecium. In this type of placentation placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows, as in pea. There is no true placenta. ***e.g.*** **Pea** (Leguminosae family).

Marginal (L.S.)

(b) Axile :

This type of placentation is found in multicarpellary, syncarpous gynoecium. Ovary is multilocular and the ovules are borne on the central axis. Number of chambers are equal to the number of carpels fused. ***e.g.*** **China rose, Lemon, Tomato**.

Axile

(c) Parietal :

- This type of placentation is found in unilocular syncarpous ovary. The ovules develop on the inner wall of the ovary or on peripheral part.
  e.g. **Mustard** and ***Argemone***.
- In some plants, ovary is one chambered but it becomes two chambered due to formation of false septum or replum. Cruciferae family.
  e.g. **Mustard,** ***Capsella*** and ***Argemone***.

Parietal

(d) Free Central/Central :

This type of placentation is found in syncarpous gynoecium. In it, the ovary is unilocular (septa are absent) and the ovules are borne on the central axis.
e.g. ***Primrose, Dianthus***

Free central

(e) Basal :

The ovary is unilocular and the placenta develops at the base of ovary and a single ovule is attached at the base of ovary. ***e.g.*** **Marigold, Sunflower** (Asteraceae/ Compositae family), **Gramineae / Poaceae family**.

Basal (L.S.)

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7. The Fruit :

- The fruit is the characteristic feature of the flowering plants. It is the mature or ripened ovary, developed after fertilization.
- If a fruit is formed without fertilization of ovary, it is called a parthenocarpic fruit. In some fruits like grapes, banana seeds are not found and such type of fruits are called parthenocarpic or seedless fruits. Parthenocarpy can be induced through the application of growth hormones.

(1) Pericarp (Fruit Wall) :

After ripening, the ovary wall changes into pericarp. This pericarp may be thick and fleshy or thick and hard or thin and soft.

In fleshy fruits pericarp (fruit wall) is made up of 3 layers :-

(a) Outermost layer = Epicarp

(b) Middle layer = Mesocarp

(c) Innermost layer = Endocarp

(A) Epicarp : It is the outermost layer, it may be thick or thin and hard or soft. It forms outermost layer of fruit which is also called rind

(B) Mesocarp : It is the middle layer which is thick and fleshy in **mango**, peach and date palm. In **coconut**, this layer is made up of fibres which is also called coir

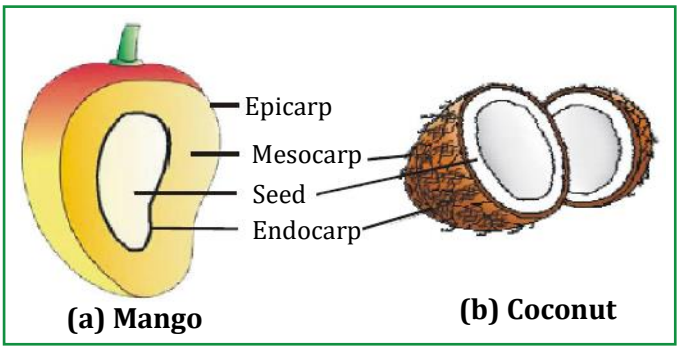
(C) Endocarp : It forms the innermost layer, it may be thin membranous ***e.g.*** **Orange, Datepalm** or thick and hard (***e.g.*** **Mango, Coconut**)

(2) True & False Fruits :

(A) True Fruit or Eucarp/Eucarpic Fruit :

When the fruit is developed only from the ovary then the fruit is called true fruit.

e.g. **Mango, Coconut**.



(B) False Fruit or Pseudocarp/Pseudocarpic Fruit :

In some fruits, in place of ovary, some other parts of flower like thalamus, calyx and inflorescence are modified into fruit or a part of fruit.

e.g. **Apple, Strawberry, Pear**, Mulberry, fig, cashew nut in apple, strawberry, cashew, etc. the thalamus also contributes to fruit formation. Such fruits are called false fruits.

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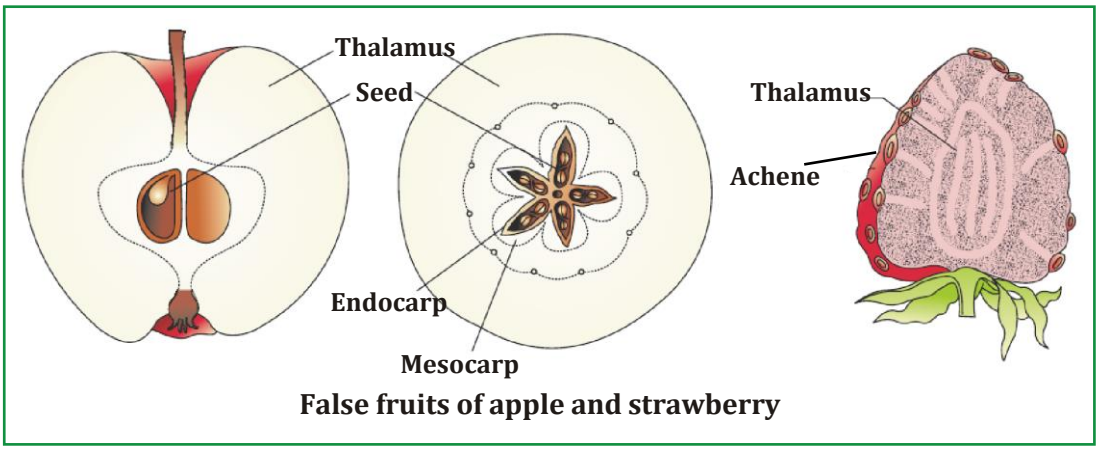
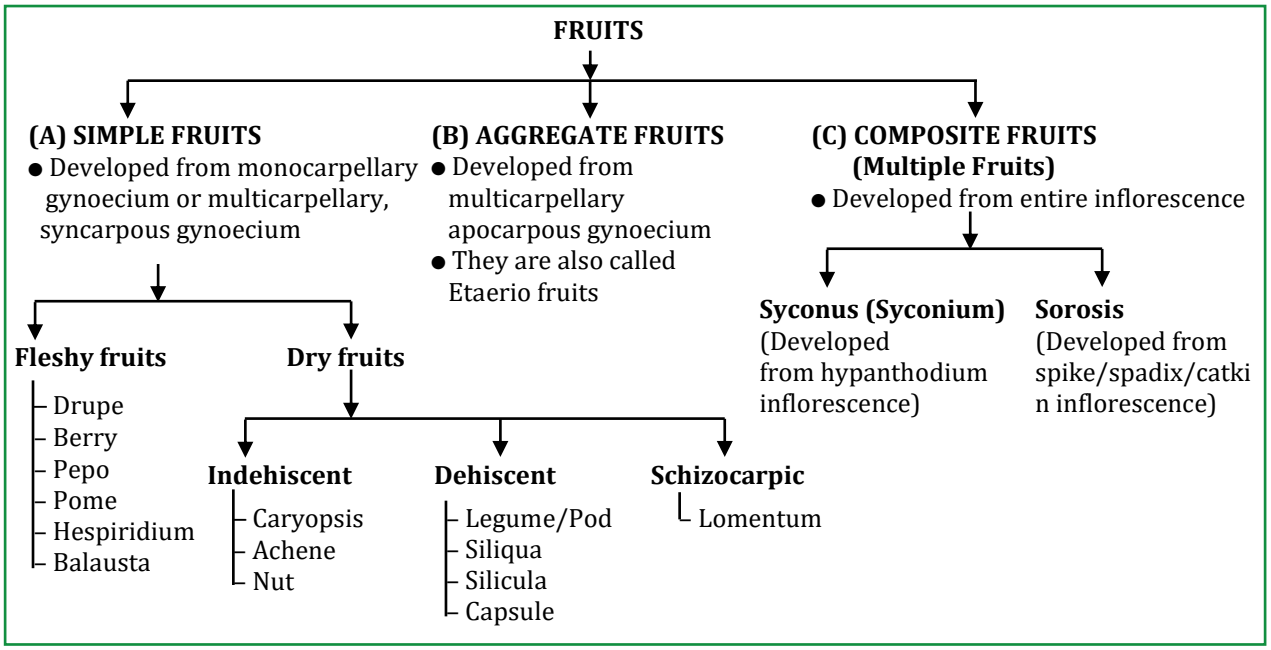


False fruits of apple and strawberry

(3) Classification of Fruits :



Fruits are divided into 3 types :

(A) Simple Fruits : These fruits **develop from ovary of monocarpellary gynoecium or multicarpellary, syncarpous gynoecium** and only one fruit is formed by the gynoecium. Simple fruits are of two types :

(i) Simple Fleshy fruits **(ii) Simple Dry fruits**

(i) Simple Fleshy fruits : In fleshy fruits, **fruit wall (pericarp) is differentiated into epicarp, mesocarp and endocarp**, these fruits are indehiscent. Fleshy fruits are of following types :

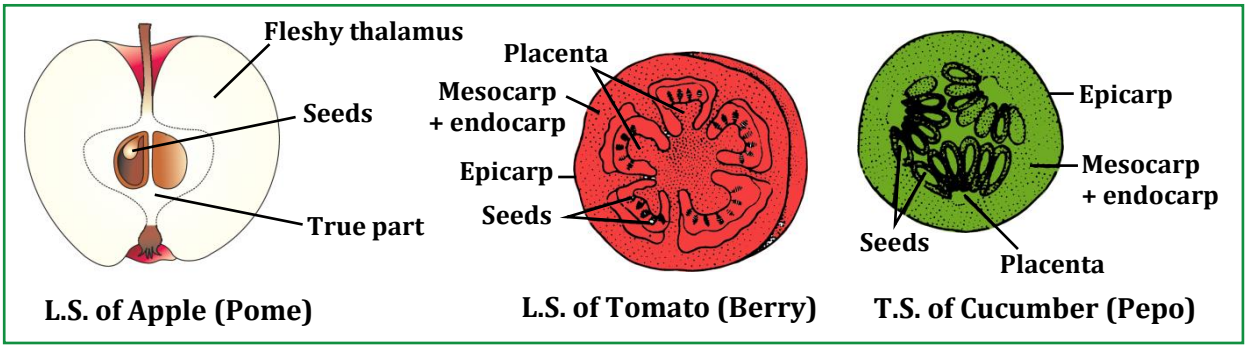
(a) Drupe fruits : **These fruits develop from monocarpellary, superior ovaries and are one seeded. In these fruits endocarp is hard and stony**, so these fruits are **also called stony fruits**. ***e.g.*** **Mango, Coconut, Almond, Peach, Walnut, Plum**. In mango the outermost cover or thin rind is called epicarp. Middle edible fleshy part is mesocarp and the inner stony hard endocarp. In plum (Ber), epicarp and mesocarp both are edible while endocarp is stony.

The hard covering of almond and walnut is endocarp and their edible part is seed. In coconut epicarp is hard and thin while mesocarp is thick and fibrous. The endocarp is hard and seed is protected in it. The sweet water and edible part of coconut are liquid and solid endosperm respectively.

(b) **Berry :** These fruits develop from mono or multicarpellary, syncarpous ovary. Ovary may be superior or inferior. **Placentation is axile. Generally epicarp is thin membrane like and seeds are embedded in fleshy part. Initially seeds are attached with placenta** of fruit but after maturation these seeds are detached from placenta and are spread randomly in fleshy part. ***e.g.*** **Tomato, Grapes, Brinjal, Guava, Banana** (date palm and betelnut are single seeded berry)

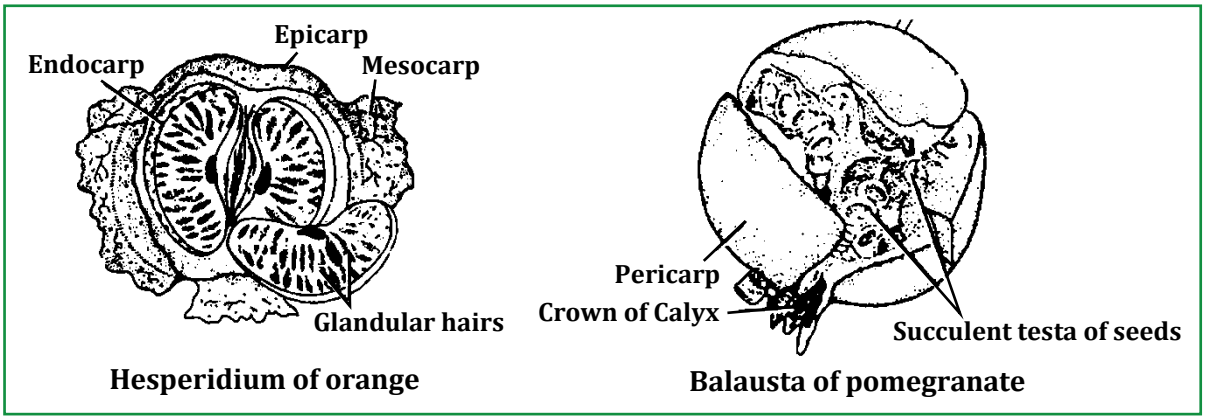
(c) **Pepo : These fruits are developed from inferior ovaries. They have parietal placentation but looks like axile due to swelling of placenta. *e.g.* fruits of cucurbitaceae family** like cucumber (khira), water melon (tarbooz), Cucurbita maxima (pumpkin), bitter gourd (karela), muskmelon (kharbuja)..

(d) **Pome : This fruit develops from inferior ovary and having enlarged thalamus *e.g.* Apple, Pear**. These are false fruits. Fleshy swollen thalamus of these fruits is edible part.



(e) **Hesperidium :** They have **axile placentation**. This fruit is specially found in the plants of Rutaceae family. ***e.g.*** **Orange, Lemon. Epicarp of these fruits is made up of thick rind which is having many oil glands. Mesocarp is the white fibrous structure which is attached with epicarp. Membranous endocarp projects inward and forms many chambers**. Many glandular hairs are present on the inner side of endocarp. These **glandular juicy hairs** are edible.

(f) **Balausta :** This fruit, **develops from inferior ovary. Calyx is persistent which is arranged in the form of crown. Testa of seed is fleshy and juicy. Testa** is the edible part.
e.g. **Pomegranate** (*Punica granatum*) = anar.



(ii) **Simple Dry-fruits :** **Pericarp (fruit wall) of simple dry fruits is not diffrentiated into epicarp, mesocarp and endocarp**. In some dry fruits, pericarp dehisces/ruptures after ripening and seeds are dispersed, such fruits are called **dehiscent fruits**. In some fruits, pericarp breaks/splits into one or more seeded segments, such fruits are called schizocarpic fruits. In some fruits, pericarp does not dehisce even after maturing/ripening, such fruits are called **indehiscent fruits**.
Simple dry fruits can be divided into following three groups :
(a) Indehiscent fruits **(b) Dehiscent fruits** **(c) Schizocarpic fruits**

(a) **Indehiscent Fruits :** These fruits do not dehisce/rupture. These simple dry fruits are generally of small sized and single seeded.

- **Caryopsis :-**These are small, one seeded dry fruits, which develop from monocarpellary, superior ovary. In these fruits Pericarp is fused with the seed coat and form a joint surface. These fruits are present in family Gramineae. ***e.g.*** **Wheat, Rice, Maize** etc.
- **Nut :-**This is a single seeded fruit, its pericarp is hard. ***e.g.*** **Cashewnut, Trapa** (water chest-nut), litchi. In litchi epicarp and mesocarp is fused and give leathery appearance. Endocarp is membrane like thin. An additional coat around the seed is formed which is called aril. Actually, it is a sort of third integument. In mature fruit, this aril is fleshy and is only edible part.
- **Achene :-** Single seeded indehiscent fruit in which seed coat is not fused with fruit wall, called as **achene**.
  Note :- In strawberry etaerio of achene is developed by the apocarpous gynoecium.

Caryopsis of rice and wheat

Nut of Litchi

(b) **Dehiscent Fruits :-** Pericarp of these fruits gets ruptured after ripening and seeds are dispersed outside. These fruits are of following types :

- **Legume or Pod :-** These fruits develop from monocarpellary, unilocular, superior ovary with marginal placentation. They are generally long and multiseeded fruits. Dehiscense of fruit occurs at both sutures i.e. dorsal and ventral suture. **Dehiscence starts from apex/tip and reaches to basal part**. ***e.g.*** **Pea, Beans, Gram**.
- **Siliqua :-** This fruit develops from bicarpellary, syncarpous, superior ovary and ovary has **parietal placentation**. Dehiscence occurs from both dorsal and ventral suture, **Dehiscence starts from lower part and proceeds upward (from base to the apex)**. Initially ovary is unilocular but due to formation of **false septum/ replum** ovary becomes bilocular later on. On false septum seeds are attached. This type of fruit is found in Cruciferae family. ***e.g.*** ***Brassica*** (mustard).

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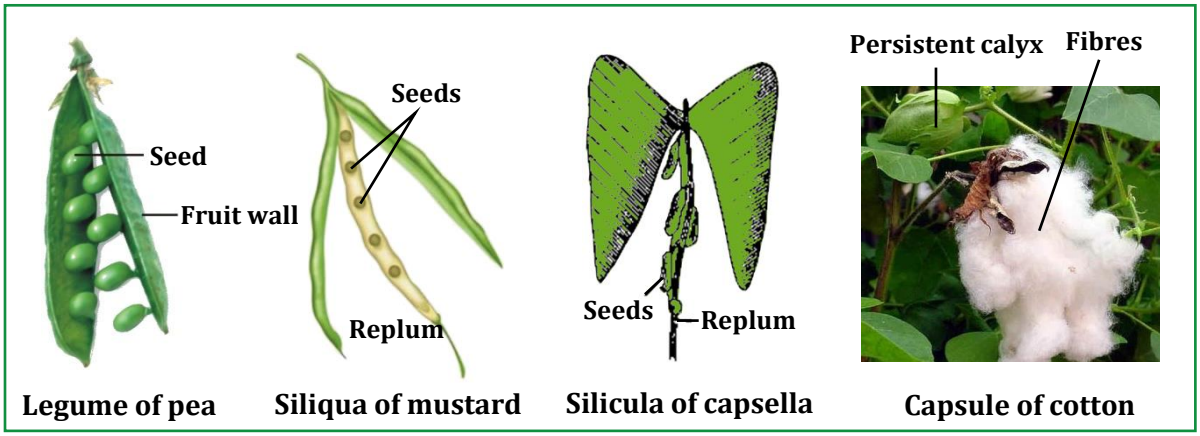
- **Silicula :-** **Small, broad siliqua is known as silicula**. It is reduced form of siliqua. ***e.g.*** **Candytuft** (*Iberis amara*), *Capsella*

- **Capsule :-** **Dehiscence occurs by various methods**. Poricidal (Porous), loculicidal, septifragal, septicidal. ***e.g.*** ***Papaver*** (poppy=opium plant), ***Gossypium*** (cotton), ***Datura, Abelmoschus*** (lady finger), **Onion**



(c) **Schizocarpic Fruits = Splitting Fruits :-** **After ripening, they break/split and divide into mericarps** and after destruction of pericarp seed comes out. **Each mericarp contains one or two seeds (Usually one seed).**

Lomentum :- These fruits are splitted in one seeded many mericarps, after maturity mericarps get separated with each other. ***e.g.*** **Tamarind,** ***Cassia, Arachis hypogea*** (*ground nut/ pea nut*), ***Acacia*** (babool).

(C) Aggregate Fruits :

- These fruits develop from multicarpellary, apocarpous gynoecium. In apocarpous condition each carpel is free from each other and it forms a fruitlet. Aggregate fruits are made up of a bunch of fruitlets which is known as etaerio.

(D) Composite Fruits = Multiple Fruits :

- All composite fruits are false fruits. In composite fruits, **generally whole inflorescence is modify into fruit**.

  Syconium :- This fruit **develops from hypanthodium inflorescence**. Many achenes develop from the pistillate flowers. ***e.g.*** ***Ficus*** **species** like Fig [anjeer (Ficus carica)], peepal (Ficus religiose).

Edible parts of some important fruits		
Plant		**Edible parts**
1.	*Anacardium occidentale*/Cashewnut/ Kaju	Cotyledons and Peduncle
2.	*Ananas comosus* = *A. sativus*/Pineapple	Fleshy axis, bracts, fused perianth & Pericarp / Outer portion of receptacle
3.	*Arachis hypogea*/Ground nut/Peanut	Seeds/Cotyledons
4.	Cereals, *Oryza*, *sativa* (Rice), *Hordeum vulgare* (Barley), *Triticum aestivum* (Bread Wheat), *Zea mays* (Maize)	Whole caryopsis fruit (Endosperm and embryo)

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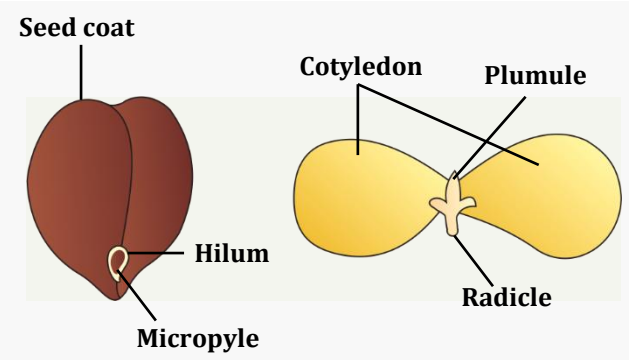
5.	*Citrus reticulata*/Orange, *Citrus sinensis*/ Sweet Orange, *Citrus aurantifolia*/Lime	Juicy glandular hair
6.	*Cocos nucifera*/Coconut	Endosperm
7.	*Ficus carica*/Fig/Anjeer	Fleshy receptacle
8.	*Fragaria ananassa*/Strawberry	Fleshy thalamus
9.	*Litchi chinensis*/Litchi	Aril
10.	*Lycopersicom esculentum*/Tomato	Whole fruit (Pericarp and placenta)
11.	*Pyrus malus* (M. sylvestris)/Apple	Fleshy thalamus
12.	*Mangifera indica*/Mango	Mesocarp
13.	*Phoenix dactylifera*/Date/Khajoor	Pericarp
14.	*Prunus amygdalus*/Almond	Seed (Cotyledons and embryo)
15.	*Punica granatum*, Pomegranate/Anar	Fleshy (Succulent) and juicy testa of seeds

8. The Seed :

- The ovules after fertilisation, develop into seeds.
- A seed is made up of a seed coat and an embryo.
- The embryo is made up of a radicle, an embryonal axis and one (as in wheat, maize) or two cotyledons (as in gram and pea).



Structure of dicotyledonous seed

(A) Structure of a Dicotyledonous Seed :

- The outermost covering of a seed is the seed coat. The seed coat has two layers, the outer **testa** and the inner **tegmen**.
- The **hilum** is a scar on the seed coat through which the developing seeds were attached to the fruit. Above the hilum, is a small pore called the **micropyle**. Within the seed coat is the embryo, consisting of an embryonal axis and two cotyledons. The cotyledons are often fleshy and full of reserve food materials.
- At the two ends of the embryonal axis are present the radicle and the plumule.
- In some seeds such as castor, the **endosperm** formed as a result of double fertilisation, is a food storing tissue and called endospermic seeds.
- In plants such as bean, gram and pea, the endosperm is not present in mature seeds and such seeds are called non- endospermous.

(B) Structure of Monocotyledonous Seed :

- Generally, monocotyledonous seeds are endospermic but some as in orchids are non-endospermic.
- In the seeds of cereals such as maize, the seed coat is membranous and generally fused with the fruit wall. The endosperm is bulky and stores food.
- The outer covering of endosperm separates the embryo by a proteinous layer called **aleurone layer**.

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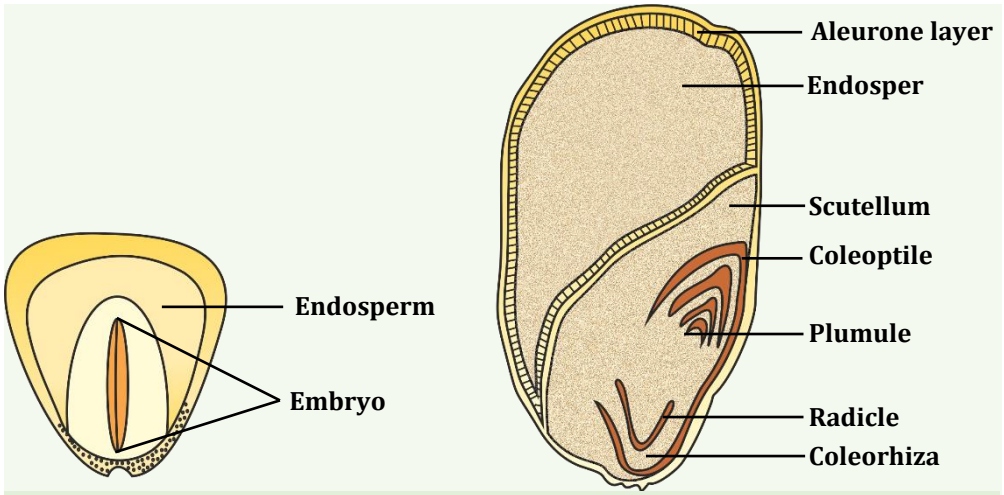
- The embryo is small and situated in a groove at one end of the endosperm. It consists of one large and shield shaped cotyledon known as **scutellum** and a short axis with a **plumule** and a **radicle**. The plumule and radicle are enclosed in sheaths which are called **coleoptile** and **coleorhiza** respectively.



Structure of a monocotyledonous seed

9. Semi-Technical Description of a Typical Flowering Plant :

Various morphological features are used to describe a flowering plant. The description has to be brief, in a simple and scientific language and presented in a proper sequence. The floral formula is represented by some symbols.

Following symbols are used for floral formula :-

Bracteate	=	Br
Ebracteate	=	Ebr
Actinomorphic	=	$\oplus$
Zygomorphic	=	% $\perp$ or Φ or ÷
Bisexual	=	$\varphi\!\!\!\!\sigma$
Unisexual male (staminate)	=	σ
Unisexual female (Pistillate)	=	φ
Epicalyx	=	Epi or Epik.
Calyx	=	K → K_n - Polysepalous condition K → $K_{(n)}$ - Gamosepalous condition
Corolla	=	C → C_n - Polysepalous condition C → $C_{(n)}$ - Gamosepalous condition
Perianth	=	P → P_n - Polyphyllous or polytepalous condition P → $P_{(n)}$ - Gamophyllous or gamotepalous condition

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Androecium	=	$A \rightarrow A_n$ - Polyandrous condition; $A \rightarrow A_{(n)}$ - Cohesion condition
Gynoecium	=	$G \rightarrow G_n$ - Apocarpous condition; $G \rightarrow G_{(n)}$ - Syncarpous condition
Superior ovary	=	Hypogynous flower = $\underline{G}$
Inferior ovary	=	Epigynous flower = $\overline{G}$
Ovary half inferior or half superior	=	Perigynous flower = G–

Adhesion

Epiphyllous condition (or epitepalous condition)	=	$\overset{\frown}{P\,A}$
Epipetalous condition	=	$\overset{\frown}{C\,A}$
Gynandrous condition	=	$\overset{\frown}{A\,G}$

10. Description of some important families

(1) Cruciferae [= Brassicaceae] = Mustard family

(A) Floral Characters :

(i) Inflorescence- Typical raceme. ***e.g.*** Mustard, Radish etc.

(ii) Flower : - Ebracteate Bisexual or hermaphrodite Actinomorphic, hypogynous and tetramerous.

(iii) Calyx : -Sepals 4, polysepalous, calyx arranged in two whorls 2 outer and 2 inner, imbricate aestivation.

(iv) Corolla : -Petals 4, polypetalous, **valvate aestivation and cruciform/cross form**.
Each petal in cruciferae is divided into two parts -long claw and broader (spreading) lamina-limb. i.e., clawed petals.

(v) Androecium: -**Stamens 6**, arranged in two whorls - In which two outer stamens are small and inner four stamens are long, this condition is known as **tetradynamous. Polyandrous, Dithecous, Tetrasporangiate.**

(vi) Gynoecium: -Bicarpellary, syncarpous, Parietal placenta.
The ovary is unilocular in the beginning but it becomes bilocular later on due to the formation of a false septum (replum). Replum is developed from the thalamus in place of wall of the ovary.

(vii) Fruit: -Usually siliqua ***e.g.*** **Mustard**
Silicula fruit is found in *Capsella*. The small and broad siliqua is known as silicula.

(viii) Seeds : Non-endospermic

(ix) Floral formula:- $\oplus\ \female\ K_{2+2}\ C_4\ A_{2\,+\,4}\ \underline{G}_{(2)}$

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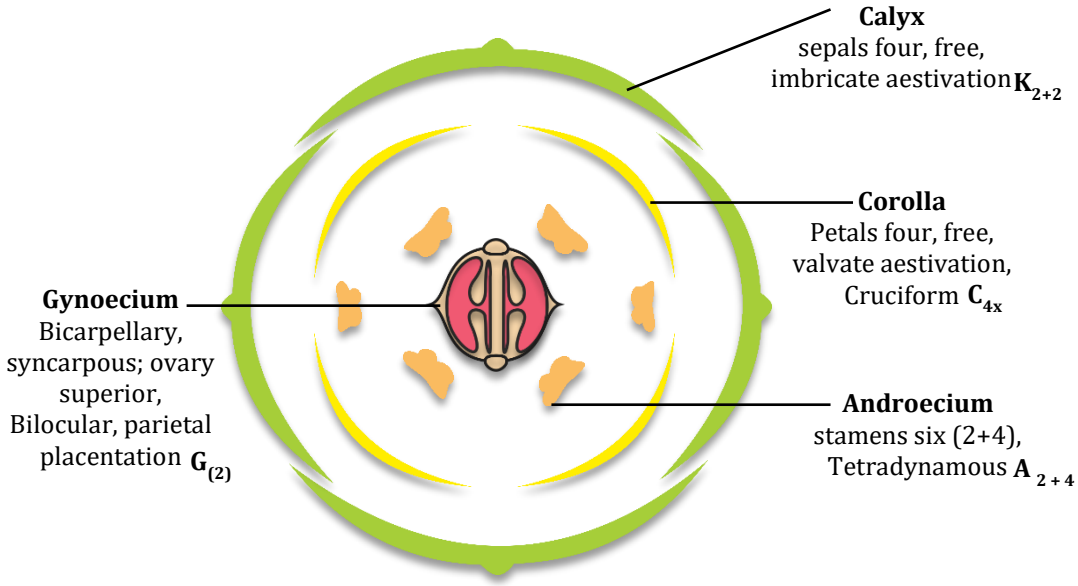

Floral Diagram

(B) Economic importance : The family includes a large number of plant species which are of immense importance to mankind as follows :-

(i) Food stuff :

(a) Radish (Muli) = ***Raphanus sativus*** - Fusiform root.

(b) Turnip (Shaljam) = ***Brassica rapa*** - Napiform root

(c) Cauliflower (Phool gobhi) = ***Brassica oleracea var. botrytis***, immature inflorescence is edible.

(d) Cabbage (Patta gobhi) = ***Brassica oleracea var. capitata***, fleshy leaves of bud are edible.

(e) Mustard (Sarson) = ***Brassica campestris***.

(ii) Ornamental plants :

(a) Chandni (Candy tuft) = ***Iberis amara***

(b) Shepherd's purse = ***Capsella bursa -pestoris***

(2) Fabaceae :

This family was earlier called Papilionoideae, a subfamily of family Leguminosae. It is distributed all over the world.

(A) Vegetative Characters : Trees, shrubs, herbs; root with root nodules

Stem :- Erect or climber

Leaves :- Alternate, pinnately compound or simple; leaf base, pulvinate; stipulate; venation reticulate.

(B) Floral characters :

(i) Inflorescence :- Racemose

(ii) Flower :- Bisexual, Zygomorphic, Pentamerous, Hypogynous.

(iii) Calyx :- Sepals five, gamosepalous; valvate/imbricate aestivation

(iv) Corolla :- Petals five, polypetalous, papilionaceous, consisting of a posterior standard, two lateral wings, two anterior ones forming a keel (enclosing stamens and pistil), vexillary aestivation

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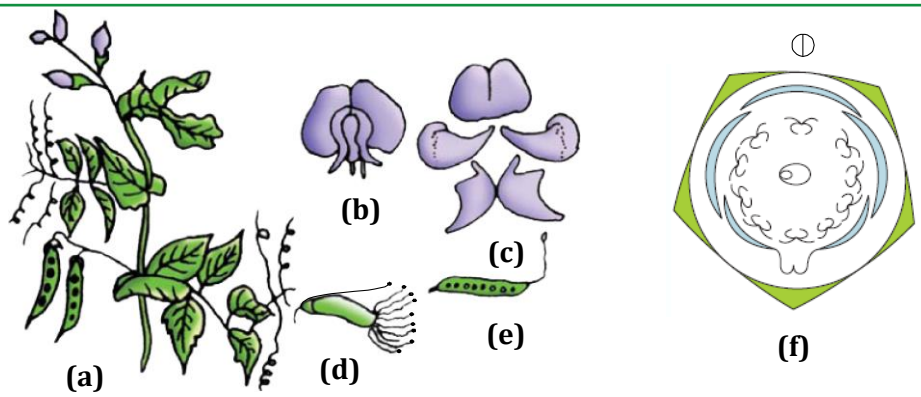

***Pisum sativum* (pea) plant : (a) Flowering twig (b) Flower (c) Petals (d) Reproductive parts (e) L.S. of carpel (f) Floral diagram**

(v) Androecium :- Ten, diadelphous, anther dithecous, Tetrasporangiate.
(vi) Gynoecium :- Ovary superior, mono carpellary, unilocular with many ovules, style single
(vii) Fruit :- Legume; seed: one to many, non-endospermic

(viii) Floral Formula : $\%\,\male\,\female\ K_{(5)}+C_{1+2+(2)}A_{(9)+1}\,\underline{G}_1$

(C) Economic Importance :

(i)	**Food Plant :**		
	(a) Arhar (Pigeon pea) - **Pulse**	=	***Cajanus cajan (indicus)***
	(b) Chana (Gram) - **Pulse**	=	***Cicer arietinum***
	(c) Mattar (Pea)	=	***Pisum sativum***
	(d) Mung (green gram) - Pulse	=	***Phaseolus radiatus or Vigna* radiatus**
	(e) Soyabean - Pulse	=	***Glycine max (G. soja).* Soyabean contains more protein than meat**
	(f) Mungphali (Ground nut or pea nut)	=	***Arachis hypogea.***
(ii)	**Fodder :**		
	[a] Berseem	=	*Trifolium alexandrium.* Used as green manure also.
	[b] Dhaincha	=	*Sesbania*
(iii)	**Fibres :**		
	Sunhemp	=	***Crotalaria juncea***
(iv)	**Timber :**		
	Shisham	=	***Dalbergia sissoo (Indian Red Wood)***
(v)	**Dyes :**		
	Neel (Blue dye)	=	***Indigofera tinctoria*** (dye is obtained from leaves)
(vi)	**Medicinal plants :**		
	Mulaithi (Liquorice)	=	***Glycyrrhiza glabra*** Its **roots** and rhizome are used in **cough & cold.**
(vii)	**Ornamentals :**		
	(a) *Sweet pea* (Phool matar)	=	***Lathyrus odoratus***
	(b) *Lupin*	=	***Lupinus albus***
(viii)	**Edible oil :**	=	**Soyabean, groundnut**

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(3) Solanaceae :

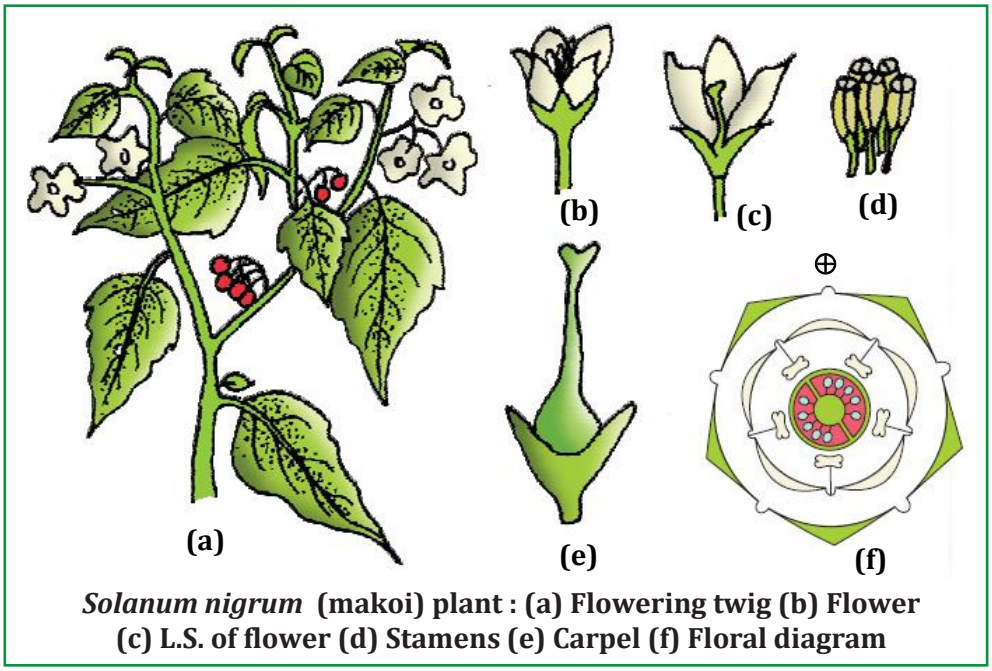
It is a large family, commonly called as the 'potato family'. It is widely distributed in tropics, subtropics and even temperate zones.

(A) Vegetative Characters :

Plants mostly herbs, shrubs and rarely small trees

Stem:- Herbaceous rarely woody, aerial, erect, cylindrical, branched, solid or hollow, hairy or glabrous, underground stem in potato (*Solanum tuberosum*)

Leaves :- Alternate, simple, rarely pinnately compound, exstipulate; venation reticulate.



Solanum nigrum (makoi) plant : (a) Flowering twig (b) Flower (c) L.S. of flower (d) Stamens (e) Carpel (f) Floral diagram

(B) Floral Characters :

(i) Inflorescence :- Solitary, axillary or cymose as in *Solanum*

(ii) Flower :- Bisexual, actinomorphic

(iii) Calyx :- Sepals five, united, persistent, valvate aestivation

(iv) Corolla :- Petals five, united; valvate aestivation

(v) Androecium :- Stamens five, epipetalous

(vi) Gynoecium :- Bicarpellary obliquely placed, syncarpous, ovary superior, bilocular, swollen axile placenta with many ovules.

(vii) Fruits :-

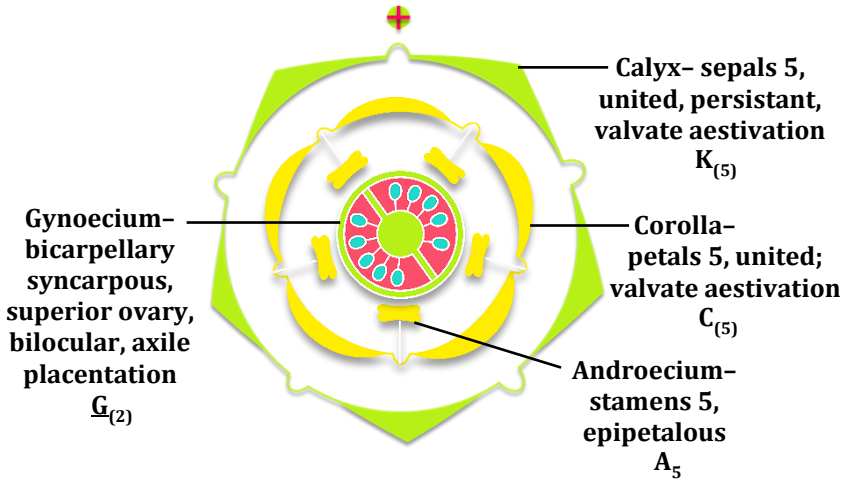
Berry or capsule

(viii) Seeds :-

Many, endospermous

(ix) Floral formula :

$\oplus \, ♀ \, K_{(5)} + \overset{\frown}{C_{(5)}} A_5 \underline{G}_{(2)}$


Calyx– sepals 5, united, persistant, valvate aestivation K(5)
Corolla– petals 5, united; valvate aestivation C(5)
Androecium– stamens 5, epipetalous A5
Gynoecium– bicarpellary syncarpous, superior ovary, bilocular, axile placentation G(2)

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(C) Economic Importance :

(i) Food :

(a) Potato = *Solanum tuberosum* - edible part is **under ground stem- tuber**

(b) Tomato = *Lycopersicum esculentum*

(c) Brinjal (Egg plant) = ***Solanum melongena***

(d) Makoi = *Solanum nigrum*

(e) Chilli = *Capsicum annuum* (used as spice)

(ii) Medicines :-

(a) *Atropa belladonna* (Deadly night shade) The roots are used in the manufacture of **drug belladonna**.
Atropine alkaloids is obtained from its roots which is used to dilate the pupil of the eye.

(b) Nicotine alkaloid is obtained from the leaves of ***Nicotiana tabacum* (Tobacco)** & N. rustica.
It is nerve stimulent and are also used as insecticide.

(c) *Withania somnifera* = Asvagandh/**Ashwagandha** - Its root are used as nerve health tonic.

(iii) Ornamental Plants :- Many plants of the family are cultivated for their beautiful flower and fragrance as follows:-

(a) *Petunia alba* and *Petunia hybrida*.

(b) *Cestrum nocturnum* = Rat - Ki - Rani (Night Jasmine)

(c) *Cestrum diurnum* = Din - Ka - Raja (Day Jasmine)

(iv) Fumigatory : Tobacco (*Nicotiana tabacum*)

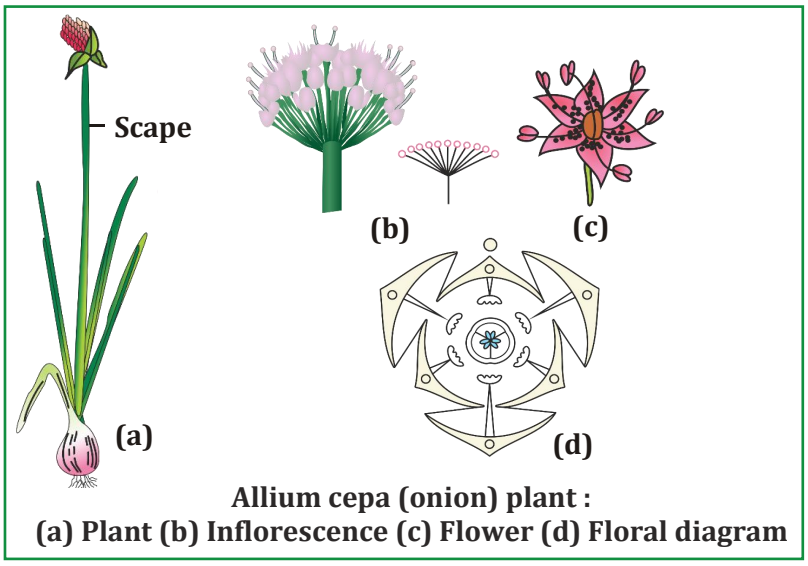
(4) Liliaceae :

Commonly called the 'Lily family' is a characteristic representative of monocotyledonous plants. It is distributed worldwide.

(A) Vegetative characters :

Perennial herbs with underground bulbs/corms/ rhizomes.

Leaves: Mostly basal, alternate, linear, exstipulate with parallel venation



Allium cepa (onion) plant :
(a) Plant (b) Inflorescence (c) Flower (d) Floral diagram

(B) Floral characters

(i) Inflorescence :- Solitary / cymose; often umbellate clusters.

(ii) Flower :- Bisexual; actinomorphic.

(iii) Perianth :- Tepal six (3+3), often united into tube; valvate aestivation.

(iv) Androecium :- Stamen six, 3+3, epitepalous.

(v) Gynoecium :- Tricarpellary, syncarpous, ovary superior, trilocular with many ovules; axile placentation.

(vi) Fruit :- Capsule, rarely berry.

(vii) Seed :- Endospermous

(viii) Floral Formula : $Br \oplus \delta\,\varphi\ \overset{\frown}{P}_{(3+3)} + A_{3+3}\underline{G}_{(3)}$

(C) Economic Importance :

(i) Food : Onion = *Allium cepa*

Garlic = *Allium sativum* -

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Note : Antidiabetic property and pungent smell is due to sulphur containing AA- S - Allyl - Cystine Sulphoxide (SACS) in fleshy leaves of bulb.
Satawar = ***Asparagus*** **- used as vegetable**.

(ii) Ornamental plants :
Lily = ***Lilium bulbiferum***
Tulip **= Tulipa**
Gloriosa (Glory lily)

(iii) Medicinal Uses :
Gvar patha (Ghee quar) = ***Aloe vera*** - Aloin, a purgative is obtained. The juice of the leaves is used as skin tonic and it increases the eye sight.
Garlic (Lahasun) = ***Allium sativum*** = It is very useful in **heart disease, rheumatism & diabetes**.

(iv) Other Uses : ***Colchicum*** **autumnale - Colchicine (mitotic poison)** is obtained from corms of this plant, which is used to induce polyploidy in plants.

Golden Key Points

- **Bulbil :** It is modified vegetative bud with stored food, meant for vegetative reproduction. Eg. ***Agave, Oxalis, Dioscorea*** **(Yam).**
- **Cabbage** represents the **largest bud (vegetatie bud).**
- **Pistillode** : **Sterile pistil** is known as pistillode.
- **Staminode : Sterile stamen** is called staminode. eg. *Salvia*, Caesalpinoidae (*Cassia*, gulmohur, tamarind)
- **Polygamous :** A plant bearing bisexual, unisexual and even neutral flower is said to be polygamous. Eg. *Polygonum*, mango
- Half inferior ovary is found in plum, peach, rose.
- In apocarpous condition carpels are free.
- Generally the fruit consists of pericarp and seeds.
- In fabaceae, flowers are zygomorphic.
- Solanaceae is commonly called 'potato family'.
- **Syngenesious :** Only anthers are united in bundle, but filaments remain free. **e.g. Sunflower**
- **Synandrous :** Anthers as well as filaments of stamens are united through their whole length. **e.g. Cucurbits**

BEGINNER'S BOX-2 — FLOWER TO FAMILIES

1. A flower can be regarded as perfect flower when :-
(1) Only one essential whorl is present (2) Both essential whorls are present
(3) Both accessory whorls are present (4) Both essential whorls are absent

2. Beauty of *Bougainvillea* is due to :-
(1) Sepal (2) Petal (3) Bract (4) Stipule

3. Pappus is characteristic feature of :-
(1) Cotton (2) Lady finger (3) Sunflower (4) Mustard

4. Select the correct statement?
(1) In syncarpous condition one carpel is present
(2) The number of locules are always equal to number of carpels in gynoecium
(3) Free central placentation is found in primrose
(4) Arrangement of ovaries is called placentation

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5. Select incorrect statement ?
(1) Berry fruits are generally single seeded
(2) Tetradynamous stamens are found in mustard
(3) Tricarpellary gynoecium is found in members of family Liliaceae
(4) In family Cucurbitaceae, plants are generally monoecious

6. Tetradynamous (2 short and 4 long stamens) condition is seen in :-
(1) *Salvia* (2) *Mustard* (3) *Datura* (4) China rose

7. In *Dianthus*, placentation is :-
(1) Basal (2) Free central (3) Axile (4) Marginal

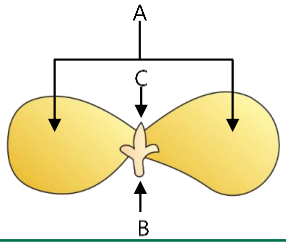
8. If the filaments of stamens are fused in a single group, the condition is :-
(1) Monoadelphous (2) Polyadelphous
(3) Both (1) and (2) (4) Diadelphous

9. Coconut fruit develops from :-
(1) Monocarpellary superior ovary (2) Monocarpellary inferior ovary
(3) Multicarpellary superior ovary (4) Multicarpellary inferior ovary

10. When a fruit is developed from ovary without fertilisation then which of the following is not correct about it :-
(1) It is parthenocarpic fruit
(2) It is true fruit
(3) Such fruits are useful to produce in all plants
(4) Mango, guava and tomato are not the parthenocarpic fruits

11. *Asparagus* gloriosa and onion belong to which family?
(1) Potato family (2) Lily family (3) Pea family (4) Mustard family

12. Identify A, B and C in given diagram below :-
(1) A-Plumule, B-Radicle, C-Cotyledon
(2) A-Seed coat, B-Plumule, C-Cotyledon
(3) A-Seed coat, B-Micropyle, C-Radicle
(4) A-Cotyledon, C-Plumule, B- Radicle



BEGINNER'S BOX ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	1	2	2	2	3	4	3	2	2
	Que.	11	12								
	Ans.	1	3								

BEGINNER'S BOX-2	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	2	3	3	3	1	2	2	1	1	3
	Que.	11	12								
	Ans.	2	4								

The root
- Tap root :- Originates from radicle
- Adventitious root: Originates from any parts of plant other than radicle

Root modification

- **Tap root modification** — Radish, carrot, turnip
- **Adventitious root modification** — Maize, banyan, *Monstera*, Asparagus, sweet potato

The Stem:
- Originates from plumule
- Nodes and internode present
- Underground stem of potato, *Colocasia* and turmeric works as organ of perennation

Stem modification

- **Sub-aerial** — Partly aerial and partly underground
  - **Runner** *Cyanodon*
  - **Stolon** Jasmine
  - **Sucker** Pineapple
  - **Offset** *Eicchornia*
- **Underground** — Completely below the Soil surface
  - **Tuber** Potato
  - **Rhizome** Turmeric, ginger
  - **Corm** ***Colocasia***
  - **Bulb** Onion Garlic
- **Aerial** — completely in air or above the soil surface
  - **Stem thorn** *Bougainvillea, Citrus*
  - **Stem Tendrils** Grapevine, Cucurbits
  - **Phylloclade** *Opuntia, Euphorbia*
  - **Cladode** *Ruscus Asparagus*

The leaf:
- Lateral appendages of stem
- Exogenously borne on nodes
- Acropetally arranged

Venation

- **Reticulate** — Dicot leaves
- **Parallel** — Monocot leaves

Types of leaves

- Simple leaves
  - –Mango
  - –Peepal
- Compound leaves
  - Pinnately compound — Neem
  - Palmately compound — Silk cotton

Phyllotaxy

- **Alternate** — Mustard, chinarose, sunflower
- **Opposite** — Guava, *Calotropis*
- **Whorled** — *Alstonia*

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Inflorescence

Racemose
- Unlimited growth of axis
- Acropetal arrangement

Cymose
- Limited growth of axis
- Basipetal arrangement

Types of flowers

Hypogynous Superior ovary

Perigynous Half inferior ovary

Epigynous Inferior ovary

Floral symmetry

Actinomorphic Mustard, *Dathura*

Zygomorphic Cassia, Pea Gulmohar

Asymmetirc *Canna*

Aestivation

Valvate Mustard, *Calotropis*

Twisted Cotton, chinarose

Imbricate *Cassia*, gulmohar

Vexillary Pea, beans

Placentation

Marginal Pea

Axile Lemon, Chinarose, tomato

Parietal *Argemone* Mustard

Free central *Dianthus*, *Primrose*

Basal Sunflower, Marigold

Flower :
- A modified shoot meant for sexual reproduction
- Unit of sexual reproduction in angiosperms
- Nodes and highly condensed internodes are present
- Calyx and corolla are accessory whorls of flowers
- Androecium and gynoecium are essential whorls of flower

Fruit :
- Ripened ovary after fertilization form fruits
- In mango and coconut drupe fruits are present
- In drupe fruits endocarp is hard and stony
- Parthenocarpic fruits are seed less

Families of angiosperms :
- A flower can be semi technically described by floral formula and floral diagram
- Position of ovary can not be determined by floral diagram
- Aestivation and placentation can not be determined by floral formula
- Adhesion and cohesion can be shown by both floral formula and floral diagram

	Floral formula	Floral diagram
Cruciferae	$\text{Ebr} \oplus \male\female K_{2+2}\, C_{4x}\, A_{2+4}\, \underline{G}_{(2)}$	
Fabaceae	$\text{Br} \circlearrowleft \male\female K_{(5)}\, C_{1+2+(2)}\, A_{(9)+1}\, \underline{G}_{1}$	
Solanaceae	$\text{Br or Ebr} \oplus \male\female K_{(5)}\, \overset{\frown}{C_{(5)}}\, A_{5}\, \underline{G}_{(2)}$	
Liliaceae	$\text{Br} \oplus \male\female \overset{\frown}{P_{(3+3)}}\, A_{3+3}\, \underline{G}_{(3)}$	